POWER

Established 1884—McGraw-Hill Publishing Company, Inc.

ELY C. HUTCHINSON, *Editor*

VOLUME 75 JUNE 21, 1932 NUMBER 25

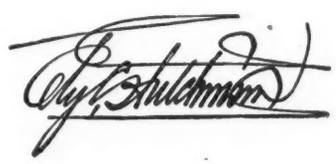
"Go, and Do Thou Likewise"

Power, discovered by humans, is in many respects like humanity. Its best work is done with an efficient and well ordered system. It does that work best which is done with least waste of effort and cost in wear and tear. Moreover, success requires not only that the system shall be capable of producing energy cheaply but that its effort be applied to maximum effect.

Knowing these things, it hurts to see power and heat, produced under highly efficient conditions, leave the power house only to have fifty to seventy-five per cent of its usefulness lost by inefficient application. Perhaps you will say this is exceptional. It is not.

Just a short time ago one of our leading process industrials saved fifty per cent of its power and heat consumption at one plant by putting power engineers into the factory. This same company also found present power and heat generating methods so far advanced that it paid to spend over a million dollars on the reconstruction of a power plant built since the war and considered modern until five or six years ago.

It is upon such foundations that present-day business is building.



EDITORIALS

Operating — A Job or Vocation?

There are two new kinds of operators, those who think their work is a whistle-to-whistle job, and those who regard it as a vocation. There are still many employers who want only "job" men and even regret no way has yet been found to do their work by machinery. And their power houses look it!

Fortunately, there are other employers—and the number is growing—who seek men who will study modern power generation from the operating viewpoint and intelligently interest themselves in their work and who realize their positions are secure only as they can make themselves more valuable.

These men have ideas and initiative. They welcome new things and seek ways to help the boss find contentment in the fact that his power house is a fine, paying investment, efficiently run and a pleasure to step into.

The results obtained by the intelligent operator—the "vocation" man—are sure to attract attention and eventually convince the old-fashioned employer he has been missing a big bet.

Metal Cavitation in Hydraulic Turbines

A recent lecture by Prof. Wilhelm Spannhake before the N.E.L.A. Hydraulic-Power Committee, published by the National Electric Light Association, gives some interesting conceptions of the causes of pitting on waterwheel parts. What to many water-power engineers may be a startling theory is that instead of pitting being caused by electro-chemical action, the metal is blasted or chemically "burned" away by bubbles collapsing on the metal's surface. When these bubbles collapse suddenly they cause a water hammer to produce pressures that may reach one-thousand atmospheres.

This theory, although not new, has not been generally known to power engineers. It was, however, included in a committee report to the British Admiralty, in 1917, dealing with pitting of ship's propellers. The committee expressed the opinion that corrosion of propellers was slight, but that erosion was serious and was caused by a hammer action of water on the propeller blades, due to collapsing of cavities in the water on the metal's surface. The report also pointed to indications that propeller blades had been bent by a peening action from water hammer of possibly several hundred tons per square inch on the blade. This theory of high pressures produced by water hammer also suggests a cause for the serious erosion and other troubles experienced at the top of draft tubes in some large propeller-turbine installations.

Prof. Spannhake indicates that the coefficient *sigma* offers an approximate measure of the elements that are conducive to cavitation. This coefficient includes among other factors the suction head on the turbine and would appear to substantiate the conclusions in the 1926 N.E.L.A. Hydraulic Power Committee report on causes of pitting on turbine runners. It was shown in that report that with a given size of runner operating with a draft head below a certain value, pitting did not occur, but when the draft head was excessive serious erosion developed.

From these various reports it is evident that qualitatively the causes of cavitation are fairly well understood, but quantitative knowledge is lacking. If the fundamental research work on cavitation, now being conducted by Prof. Spannhake and his associates at the Massachusetts Institute of Technology, adds to the latter, a contribution of great economic value will have been made to hydraulic engineering. Until this is available, many of the difficulties experienced with waterwheels and other hydraulic machinery cannot be completely solved.

Water is a Power Service

If it flows through a pipe, or a wire or a duct, it's a power service. Water does and is. The entire water supply and distribution in a factory, institution or building is a proper responsibility of the engineer. Here is room for savings often overlooked.

Costing on the average about one cent per cubic foot or about thirty cents per ton, water may seem cheap—something that anybody may use freely without feeling the pinch. Yet the aggregate consumption in a large hotel has been known to pass the sum of $100 daily. Daily baths and clean sheets, conditioned air and other American habits take their toll. Paper mills, food plants, textile finishing establishments and many other plants almost literally swim in "process" water.

While it is generally true with such large users that the engineer watches the water supply and distribution, it would help all around to have management more definitely realize that water is a power service.

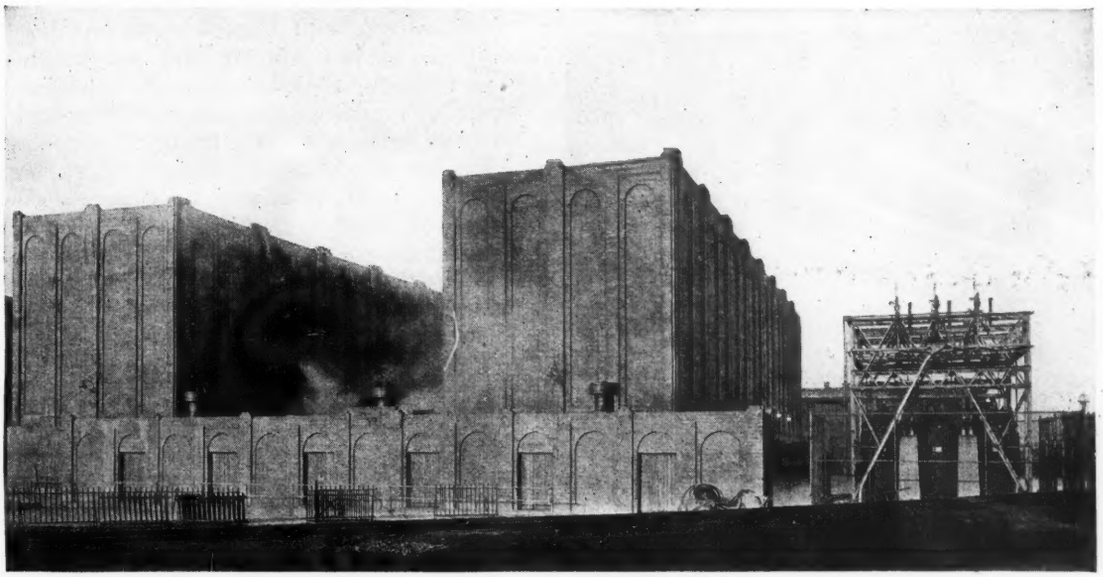
Heat balance studies pay dividends. So will studies of "water balance." It pays engineers—and owners—to compare the costs of purchased power and local generation. Why not apply the same quiz to water? What about an artesian well?

Every power program should include a militant drive on water waste.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason



Concrete cooling towers at the Hawthorne Works, looking towards the pump house

Two Forced-Draft Towers Cool Circulating Water for 34,500-kw. Plant

By W. R. LOVELESS
Engineer, Hawthorne Works, Western Electric Company

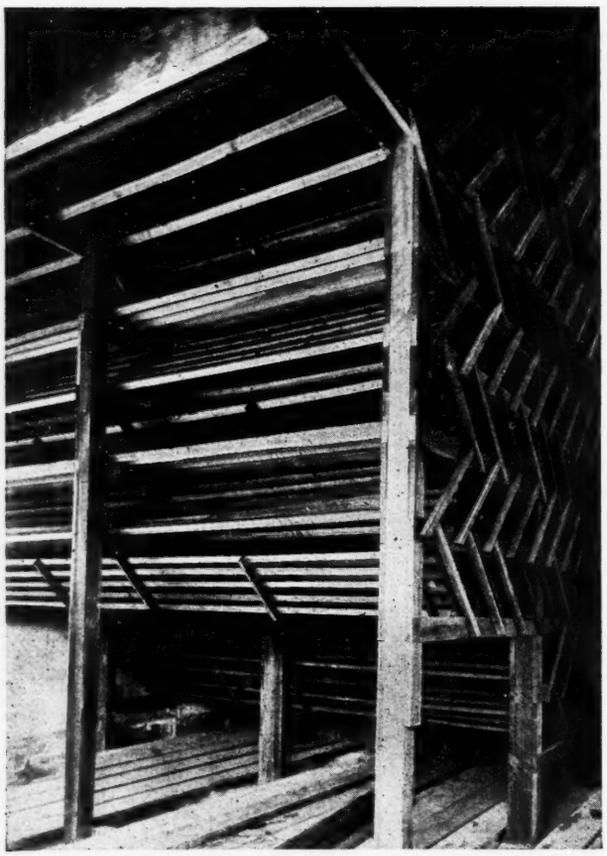
The description in *Power*[1] of the power plant at the Hawthorne works of the Western Electric Company made brief mention of these concrete shell cooling towers. It brought forth such a number of inquiries regarding details of design and operation that this explanation is merited

THE original power plant at the Hawthorne Works contained 2,000 kw. of electric generators driven by reciprocating condensing engines. Cooling water used in the surface condensers was circulated through an outdoor reservoir of approximately 4,000,000 gal. capacity and having 70,000 sq.ft. of surface area, which was primarily required by the Works fire protection system. Cooling of the circulating water was at that time obtained by surface evaporation in this reservoir, and circulation of the water between the reservoir and the condensers was accomplished by the condenser circulating pumps. Later, the power house capacity was increased, and the surface evaporation of the reservoir proved insufficient. To meet this new condition, spray nozzles were installed over the reservoir, and as the head of the condenser circulating pumps was too low to use with spray nozzles, separate pumps were installed at the reservoir for this purpose and a portion of the reservoir was used as a hot well or receiving reservoir.

As the power house requirements for heat dissipation increased, more spray nozzles and pumps were added. However, in 1926 the limit of capacity of spray nozzles that could be placed over the reservoir was reached, and as further additions to the power plant were contemplated, the question of heat dissipation became an important problem. At this time the electric load in the power plant was approximately 15,000 kw. and required the dissipation of about 200,000,000 B.t.u. per hour. It was anticipated that the ultimate amount of heat dissipation required in this power plant would be 500,000,000 B.t.u. per hour, and various preliminary plans by which this could be obtained were considered.

It was found that the continued use of spray nozzles or the use of natural-draft cooling towers would require ground area additional to the reservoir site. This in turn would necessitate occupying land not only at considerable distance from the power plant but which might, in the future, be desired as a building site. It would also entail the installation of relatively long and expensive pipe lines with resultant higher pumping costs. On the other hand, the physical size of forced-draft cooling towers would permit their installation on the area occupied by the reservoir and would require less expensive

[1]Dec. 2, 1930, "Western Electric Remodels Power Plant at Hawthorne," by C. B. Barnes.



The filling in the towers consists of cypress strips of triangular cross-section

pipe lines. After a careful study of investment and operating charges, the use of forced-draft cooling towers, located over the existing reservoir, was adopted. It was also agreed that the design of the towers would be based upon a temperature range of the condenser cooling water of 17 deg., with a maximum discharge temperature from the condensers of approximately 106 degrees.

Atmospheric Conditions Influence Capacity

An examination of the atmospheric records in the Chicago district indicated that on twenty days per year a condition existed as severe as 86 deg. temperature and 80 per cent relative humidity. As the electric power demand during the summer is normally somewhat below average because of the reduced lighting load, and as the thermal capacity of the quantity of water in the reservoir was sufficiently large to be considered in the engineering calculations, the towers were designed to deliver their rated capacity under conditions of 80 deg. and 70 per cent relative humidity.

The present installation consists of two towers each approximately 182 ft. long by 38 ft. wide and 50 ft. high. Each tower is divided into eight cells by partition walls, the inside measurements of each cell being 22x36 ft. Under the above atmospheric conditions, each cell is rated at 3,800 gal. per minute with a temperature drop of 17 deg. from an initial temperature of 106½ deg. The flow of water is 4.8 g.p.m. per square foot of cross-sectional area and approximately 66 cu.ft. of air is circulated per gallon of water. Each cell provides cooling capacity for approximately 2,000 kw. of electric generation.

Considerable thought was given to location of the cooling towers with respect to surrounding buildings, because of the possibility of vapor and entrained moisture being carried to these buildings. To minimize this possibility, the towers were constructed 50 ft. high above the foundation piers, and eventually equipped with baffles at the top to separate moisture from the outgoing air currents. As finally located, the towers are 148 ft. east and 98 ft. south of the nearest adjacent buildings, and no detrimental effect to these buildings or their contents has been observed.

Comparison of tower costs, exclusive of internal filling, indicated that the initial cost of reinforced concrete towers would be somewhat greater than the cost of towers constructed of copper-bearing steel plates and structural shapes. On the other hand, the depreciation and maintenance cost would be somewhat less for the concrete towers. Since the concrete construction permitted a more pleasing architectural treatment, and as the difference in cost was relatively small, the concrete design was selected.

Winter Construction Difficult

The construction of the towers on the reservoir area required for each tower the draining of one-half the reservoir and the removal of the spray nozzles located over that area. Due to this limiting of cooling capacity, it was necessary to construct the first tower during the winter months. This work was commenced in October, 1928, and was completed sufficiently to permit initial operation in April, 1929. Properly to protect the concrete from the freezing weather encountered, a large amount of temporary canvas enclosure was built about the work. It was also necessary to screen the work from spray blown from the adjacent spray nozzles which were in operation, and on the whole the erection of the first tower was accomplished under unusually difficult weather conditions.

The concrete structures have a gross weight of approximately 6,300,000 lb. each and are carried upon separate footings designed for a soil bearing pressure of 3,000 lb. per square foot. The footings are carried down to a hard blue clay approximately 4 ft. below the dirt bottom of the reservoir and 13 ft. below the normal water level. Above the foundation piers the sides of the base sections are 30 in. thick for a height of 12 ft. and contain openings for the 8-ft. diameter propeller fans. Above the base section the walls are extended 38 ft. The main pilasters are one foot thick by 6 ft. wide, with intermediate pilasters 11 in. thick by 2 ft. wide. The spaces between the pilasters are filled with reinforced panels 6 in. thick poured monolithic with the pilasters and without expansion joints. The arrangement of pilasters and panels was made to harmonize, to some extent, with the architectural design of the adjacent buildings.

In line with the bottom of the base section, and one foot above normal water level, there is an operating platform 5½ ft. wide on each side of each tower. These operating platforms are connected at the end of the towers by walkways 3 ft. wide. The internal filling of the towers is supported upon concrete beams whose top surfaces are 1 ft. above normal water level. The concrete foundation piers of the towers have crushed limestone and sand aggregate, but for the structure above the foundations, gravel and sand aggregate was used. The 5-day and 28-day tests of this gravel concrete showed

ultimate compression strengths of 2,000 lb. and 4,300 lb., respectively, per square inch.

Distribution of the water is entirely within the tower, the main headers being below normal water level adjacent to the tower centerline. These headers are fabricated from copper-bearing steel plate $\frac{1}{4}$ in. thick and are of 42-in. maximum diameter, tapering to 18-in. minimum diameter, with distributing pipes 16 in. in diameter being taken off at each cell and rising through the filling to the main distributing troughs. Each header pipe is controlled by a motor-operated gate valve, and each riser pipe is controlled by a manually operated butterfly valve with a valved drain connection just below the butterfly valve seat. The operating rods for the latter two valves are brought out through the side of the tower for convenience in operation from the platform.

Swamp Cypress Used for Tower Filling

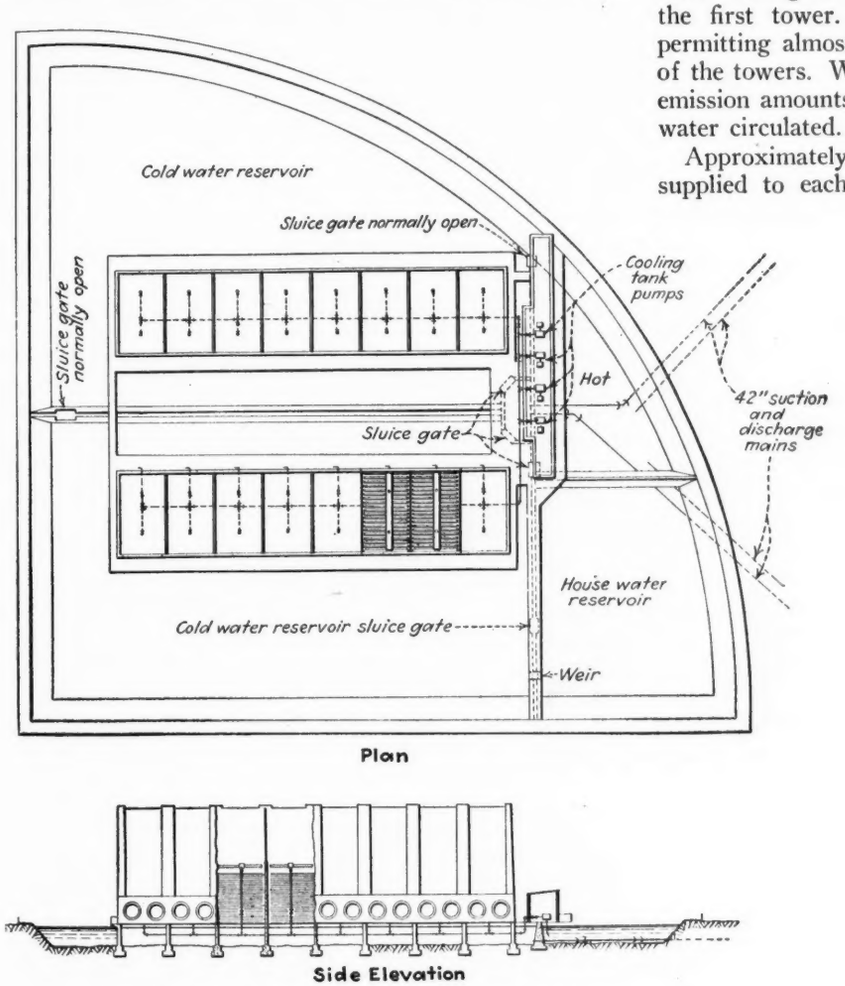
The internal water distributing troughs, filling and supporting structure, are made of the "Select Common" grade of swamp cypress. The filling is built up to 23 ft. above the reservoir, and the distributing troughs are located 3 ft. higher. Water from nozzles in the bottoms of the distributing troughs falls onto brass splash plates and thence to the filling below. Elements of the filling consist of cypress strips of triangular cross section, set with a flat side up and staggered in such a manner as to break up effectively the falling water. The elements are attached by galvanized steel nails to diagonally placed cypress joists, which in turn are supported by studding, bearing on concrete beams above the water level of the reservoir. None of the supporting structure for the filling is attached to the side walls of the tower.

The outer concrete beams at each side of the tower foundation extend $3\frac{1}{2}$ ft. below normal water level, and these beams, together with the foundation piers, seal each cell from air leakage. A cypress baffle 12 ft. high above the foundation piers extends across each cell at the centerline, preventing interference of opposing air currents from fans located at the opposite sides of the cells and directing the flow of air upwards. An interior walkway extends throughout each tower above the distributing troughs. Access to this walkway is by means of ladders at each end of the tower. Each ladder is enclosed in a cypress wood well, opening at the bottom to the outside walkway at the end of the tower.

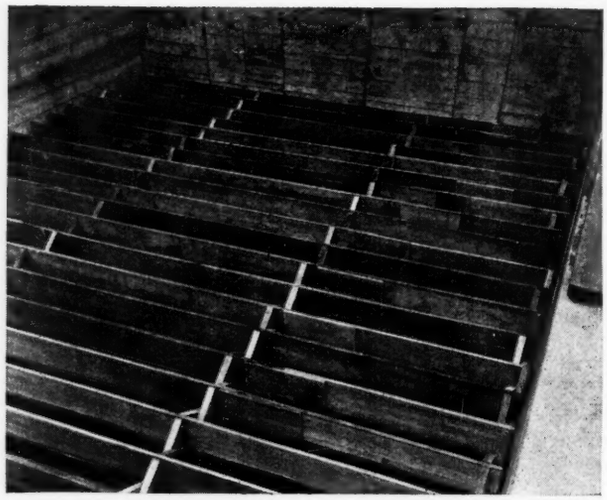
During the designing of these towers, there was some question of the necessity of installing baffles at the top of the tower structure to minimize the amount of spray and entrained moisture carried out with the air currents. The question was not settled prior to the completion of the first tower, but provisions were made for the support and installation of baffles should operation indicate that they were required. After the first tower was placed in operation, there were occasions when the atmospheric conditions were such that an objectionable amount of spray was carried out and precipitated upon the adjacent streets. Baffles were thereafter installed in the second tower during its construction, and later were installed in the first tower. These baffles functioned admirably, permitting almost no noticeable spray to be carried out of the towers. Water loss due to evaporation and spray emission amounts to slightly less than 1 per cent of the water circulated.

Approximately 250,000 cu.ft. of air per minute is supplied to each cell by four 8-ft. diameter, 2-blade, aeroplane propeller fans. Each propeller is mounted upon the extended shaft of a 15-hp. motor, supported by a cast iron pedestal designed especially to reduce resistance to air flow. The propellers operate at 690 r.p.m., and at this speed produce no objectionable noise. Much consideration was given to this feature and tests were made of 2-blade and 4-blade propellers at various speeds to determine upon a design which would be suitable in this respect. The propellers are of laminated-wood construction, mounted upon brass hubs and sheathed with Monel metal. The sheath is soldered at the seams and reinforced by rivets passing through the blade. An inspection made after two years of operation indicates that these propellers are in excellent condition. The housings of the fans are formed by openings in the base section of the tower structure, their shape carefully designed by the fan manufacturer.

The motors are rated at 15 hp., 720 r.p.m., 440 volt, 3 phase, 60 cycles, and are of the squirrel-cage,



The two cooling towers were built over the old spray pond



Baffles were installed above the wood filling to prevent water being carried out with the forced draft

standard fan-cooled construction modified to meet the severe moisture conditions under which they operate. They are equipped with ball bearings which are grease lubricated and sealed against the entrance of water. The inner bonnets over the windings are also sealed against the entrance of water, and moisture-proof insulation is used. The motors are mounted with the driving end toward the outside of the tower so that the motor itself is exposed to falling water within the tower. It is protected by a guard designed to shed this water.

In the first tower constructed, the motor control units were located in recessed pockets in the wall adjacent to to the motors. Some difficulty was experienced because of excessive moisture at these locations, and although this difficulty was overcome by the design of moisture-proof containers for the control units, it was decided to locate the controls for the fan motors of the second tower within the adjacent pump house. No trouble due to moisture has been experienced with the control equipment for the fan motors of the second tower.

Protection Provided Against Ice on Propellers

To minimize accident hazard to operating and maintenance employees, the fans are guarded by a woven wire fence 10 ft. high, with gates opposite each fan. Power disconnecting switches are located beneath each motor, and cypress wood platforms are placed inside each cell at each motor for convenience in inspection and maintenance. Additional protecting screens are placed between the adjacent cells and above the propellers of the end cells as protection from ice which might be thrown from the propeller blades. Experience has shown that conditions may exist under which ice will form upon the propellers while in operation and will be thrown off in pieces sufficiently large to be dangerous. No detrimental effect to the propellers or motors from this condition has been observed, as the ice accretion and detachment is sufficiently uniform to avoid serious unbalancing.

Circulating water for the condensers is taken through a screened intake chamber from the cold-water storage sections. A 42-in. diameter cast iron pipe loop leads to and through the power house and back to this chamber. The condensers discharge into the hot-well section of the reservoir through another similar 42-in. diameter cast iron pipe loop. Both of these loops are so valved that either half of either loop may be taken out of service for maintenance purposes if this becomes necessary.

The pumping equipment for raising water from the hot-well section of the reservoir to the distributing troughs in the towers consists of two 14,000-g.p.m. pumps, each driven by a 200-hp. motor, and two 20,000-g.p.m. pumps, each driven by a 250-hp. motor. The former had been used to supply water to the spray nozzles, but the latter two pumps were purchased and installed concurrently with the construction of the towers. They are all rated at a head of 42 ft., which provides a slight margin above the static and friction head required. The pumps are located directly over the hot-well section of the reservoir and discharge into a steel pipe manifold 42 in. in diameter to which the tower distributing headers connect through motor-driven valves. This manifold is not sectionalized because it is possible to shut down the cooling towers completely at week ends for a sufficient time to permit any probable maintenance work to be done upon the manifold. Although there is no direct connection between the condenser circulating mains and the cooling tower pumps, approximately the same amount of water is circulated through the towers as through the condensers. A sluice gate, which is normally open, between the hot and cold sections of the reservoir prevents flooding of the hot well and allows mixing of the warm and cool water when the flow is unbalanced. The pumps, together with control equipment for one tower and the local distributing switchboard, are located in a concrete structure of architectural design similar to that of the towers.

The power required for fans and pumps combined averages approximately 5.75 per cent of the total electric current generated and varies from 4.7 in the winter to 6.8 per cent during the summer months. Tests made of the cooling effect of the towers under natural draft operation indicate that this does not exceed one-eighth of the cooling effect obtained with the fans in operation. Consequently, the normal operation of the towers contemplates the operation of a sufficient number of cells under forced draft to meet the demand by the electric power generating station. Operating attention required by the cooling towers is relatively small, being limited to a brief inspection at hourly intervals.

The design and details of the concrete structures were made by Condron & Post, consulting engineers, Chicago, and the filling and fans were supplied by the Foster Wheeler Corporation. Construction work was carried out under the direct supervision of the Western Electric Company's Engineer of Plant Department.

▼ ▼ ▼

Paralleling Alternating-Current Generators—When alternating-current generators are paralleled with a synchroscope, a common mistake is to close the pilot switch when synchronism is indicated. This generally causes a severe surge between the incoming machine and those already on the system. To put the incoming machine in service with a minimum of disturbance, it should be running slightly faster, which will be indicated by the synchroscope pointer turning very slowly in the fast direction. When closing the pilot switch, allowance must be made for the time lag between the instant when it is closed and when the oil switch closes. This can be determined by trial, but a good starting point is to close the pilot switch when the pointer is moving toward the mark and about ¼ in. away.

An Analysis of POWER AND HEAT SUPPLY for Hotels—II

By L. E. HABBEN*

General considerations, electrical requirements and low-pressure steam needs were discussed in the first article, which appeared in *Power* last week. In this concluding section, the author discusses high-pressure steam requirements, comparative boiler plant and purchased steam set-ups, and over-all operation and design

LOW-PRESSURE steam demand for hot-water heating for the months of June to September is shown in curve N, Fig. 9, which is the same as curve H, except that the kitchen and laundry hot water demand has been reduced in proportion to the number of guests from 800 to 600.

By adding curves J and H, the total low-pressure steam demand for the months of December to March is obtained—see curve K, Fig. 8. By adding curves L and H, the total low-pressure steam for October, November, April and May is obtained—see curve M, Fig. 9.

High-Pressure Steam

Steam for the kitchen at 40 lb. gage will amount to approximately 31,000 lb. per day of 20 hr., or 1,550 lb. per hr. That for the laundry at 100 lb. gage will amount to approximately 24,000 lb. per day of 9 hr., or 2,666 lb. per hr. The following have been now developed:

Electrical load for October to May, curve C, Fig. 5.
Electrical load for June to September, curve D, Fig. 6.
Low-pressure steam demand for December to March, curve K, Fig. 8.
Low-pressure steam demand for Oct., Nov., April and May, curve M, Fig. 9.
Low-pressure steam demand for June to September, curve N, Fig. 9.

The steam demands will be:

For the four winter months

				Lb.
Low-pressure steam at	2 lb. gage	420,000x30x4	=	50,400,000
High-pressure steam at	40 lb. gage	31,000x30x4	=	3,720,000
High-pressure steam at	100 lb. gage	24,000x30x4	=	2,880,000
				57,000,000

For the four mid season months

				Lb.
Low-pressure steam at	2 lb. gage	233,000x30x4	=	27,960,000
High-pressure steam at	40 lb. gage	31,000x30x4	=	3,720,000
High-pressure steam at	100 lb. gage	24,000x30x4	=	2,880,000
				34,560,000

For the four summer months

Low-pressure steam at	2 lb. gage	103,000x30x4	=	12,360,000
High-pressure steam at	40 lb. gage	31,000x30x4	=	3,720,000
High-pressure steam at	100 lb. gage	24,000x30x4	=	2,880,000
				18,960,000

If this quantity of steam were purchased under a contract similar to the New York Steam Corp.'s Service Classification No. 2 with a designated monthly demand of 4,750,000 lb., the steam power bill would amount to approximately $79,000 per year.** The total annual bill for purchased power and steam, therefore, would be about $136,000.

There are many combinations of equipment which could be installed for the typical hotel, but only the following will be considered:

A. Purchased steam with steam-electric sets.
B. Boiler plant with steam-electric sets.
C. Boiler plant with steam-electric and diesel-electric sets.

The summer and winter electrical load curves, Figs. 5 and 6, are so similar that in order not to complicate matters too much, the winter (Oct.–May) curve will be used in discussing the following schemes.

A. Purchased Steam with Steam-Electric Sets

For this condition, the following have been assumed:

1. Steam condition at the throttle 125 lb. gage saturated.
2. Vertical uniflow engine sets, three 250 kw.
3. Average water rate of engines, 35 lb. per kw.-hr.
4. Heating system operating on 2 lb. gage pressure.

In Fig. 10 are plotted curves K, M and N, the low-pressure steam demand for the winter, midseason and summer months respectively. There is also plotted curve O, which represents 100 per cent of the exhaust from the engines when generating power according to curve C,

*Formerly with Lockwood Greene & Company, McClellan & Junkersfield, Ford Bacon & Davis, and the Electric Bond & Share Company.

** The New York Steam Corp's Service Classification No. 2 is as follows:
For the first 250,000 lb. of the designated monthly demand, $1.00 per 1,000 lb.
For the balance of the designated monthly demand, $0.60 per 1,000 lb.
For the first 250,000 lb. is excess of the designated monthly demand $1.25 per 1,000 lb.
For all in excess of 250,000 lb. above the designated monthly demand $0.80 per 1,000 lb.
Minimum charge for 250,000 lb. per month.
There is the usual coal charge clause in each of the above contracts which has not been considered.

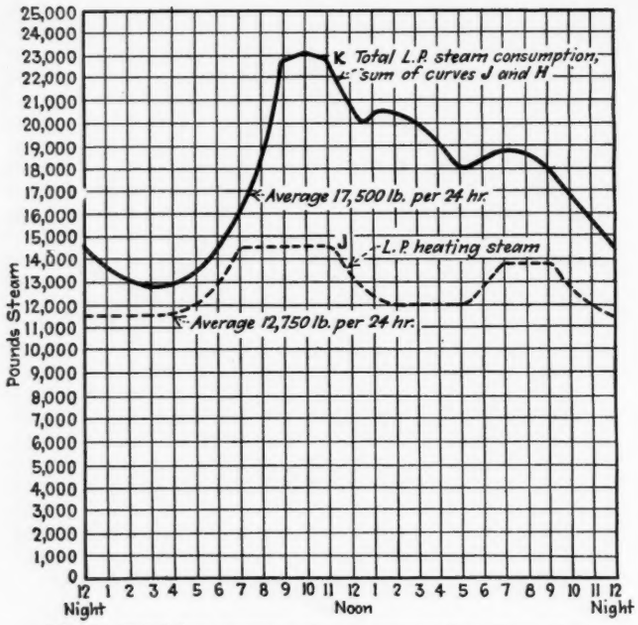


Fig. 8—Total low-pressure steam consumption (December to March inclusive)

Fig. 5, and curve P which represents 85 per cent of the engine exhaust available for heating purposes. It will be seen that at some hours there will be a waste of steam and at others some high-pressure steam will be required to augment the load. But to give purchased power the benefit of any concessions, for the present curves M and P will be considered as coincident during the midseason months.

The amount of steam which would have to be purchased under this scheme would be:

For the four winter months			Lb.
Area under curve K	17,500x24x30x4	=	50,400,000
High-pressure steam for kitchen	31,000x30x 4	=	3,720,000
High-pressure steam for laundry	24,000x30x 4	=	2,880,000
			57,000,000

For the four midseason months			Lb.
Area under curve O	325.5x35x24x120	=	32,800,000
High-pressure steam for kitchen	31,000x30x 4	=	3,720,000
High-pressure steam for laundry	24,000x30x 4	=	2,880,000
			39,400,000

For the four summer months			Lb.
Area under curve O	325.5x35x24x120	=	32,800,000
High-pressure steam for kitchen	31,000x30x 4	=	3,720,000
High-pressure steam for laundry	24,000x30x 4	=	2,880,000
			39,400,000

If this steam were purchased according to a contract similar to the New York Steam Corp.'s Service Classification No. 2 with a designated monthly demand of 9,850,000 lb., the steam power bill would amount to over $86,000 per annum.

Investment Costs	
3-250-kw. uniflow engine sets	$60,000
Foundations	7,500
Piping	3,000
Switchboard and electrical conn.	4,500
	$75,000

Operating Costs	Per Annum
Interest, depreciation, etc.	$9,750
Labor	10,000
Steam	86,648
Lubricating oil	600
	$106,998
Say	107,000

	Per Annum
Cost of operating with purchased power	$136,000
Operating costs, purchased steam only	107,000
Saving	$29,000

B. Boiler Plant with Steam-Engine Sets

For the following scheme, conditions as below have been assumed:

1. Steam conditions at throttle, 150 lb. gage 50 deg. superheat.
2. Four 2,000-sq.ft. boilers with oil-burning equipment.
3. Vertical uniflow engine sets, three 250-kw.
4. Fuel oil 18,000 B.t.u. per lb., 4c. per gal.
5. Boiler efficiency, 78 per cent.
6. Water rate of engines, 31 lb. per kw.-hr.
7. Boiler feed temperature, 197 deg. or 165 B.t.u.
8. Heating system operating on 2 lb. gage pressure.

In Fig. 11 are again plotted curves K, M and N, the low-pressure steam demands for the winter, midseason and summer months respectively. There is also plotted curve R which represents 100 per cent of the steam exhausted by the engine when generating energy according to curve C Fig. 5 and curve S, which is 85 per cent of the engine exhaust and available for heating.

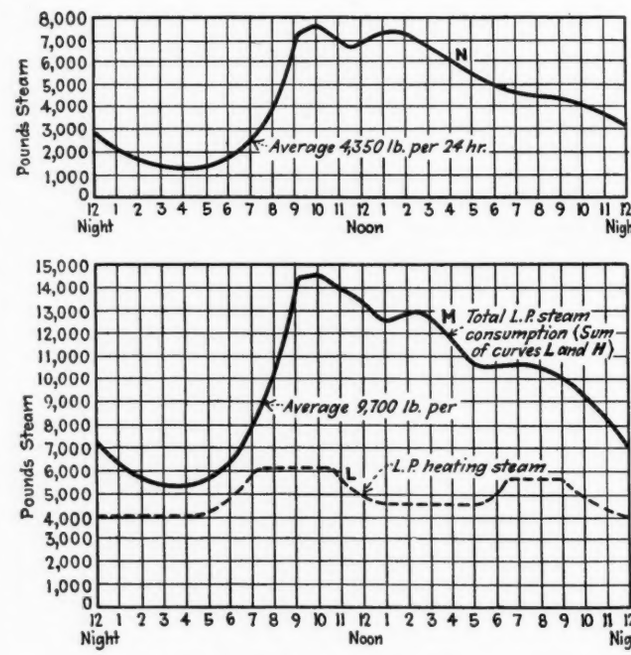


Fig. 9—Total steam consumption curves

The amount of steam to be generated by the boilers under this scheme would be.

For the four winter months			Lb.
Area under curve K	17,500x24x30x 4	=	50,400,000
High-pressure steam for kitchen	31,000x30x 4	=	3,720,000
High-pressure steam for laundry	24,000x30x 4	=	2,880,000
			57,000,000

For the four midseason months			
Area under curve R	325.5x31x24x120	=	29,000,000
Shaded area	25,000x30x 4	=	3,000,000
High-pressure steam for kitchen	31,000x30x 4	=	3,720,000
High-pressure steam for laundry	24,000x30x 4	=	2,880,000
			38,600,000

For the four summer months			
Area under curve R	325.5x31x24x120	=	29,000,000
High-pressure steam for kitchen	31,000x30x 4	=	3,720,000
High-pressure steam for laundry	24,000x30x 4	=	2,880,000
			35,600,000

This is a total of 131,200,000 lb. of steam per year.

To evaporate 1,000 lb. of water will require 9.5 gal. of fuel oil, or 38 cents per 1,000 lb. of steam.

The fuel oil bill will therefore amount to $49,856 per year.

Investment Costs	
Four 2,000 sq.ft. boilers	$20,000
Four superheaters	3,000
Feed pumps and f.w. heater	2,000
Oil tanks, pumps, piping etc.	6,500
Breeching	1,500
Foundations	1,000
Three 250-kw. uniflow engine sets	60,000
Foundations	6,000
Piping	8,000
Switchboard and electrical connections	4,500
	$112,500

Operating Costs	Per Annum
Interest, depreciation etc., 13 per cent	$14,625
Labor	14,000
Fuel oil	49,856
Lubricating oil	600
Make-up water	320
	$79,401
Say	$79,000

	Per Annum
Cost of operating with purchased power and steam	$136,000
Operating costs, boiler plant with S.E. sets	79,000
Saving	$57,000

In the above a charge has been made for make-up water, but not for water treatment, because in a first-class installation a zeolite system would in all probability be included for the laundry.

C. Boiler Plant with Steam Engine and Diesel Sets

First, the size of the diesel set must be determined. From curve N, the minimum demand for steam is seen to be 1,300 lb. per hr.; at 31 lb. per kw.-hr., a steam engine will develop 42 kw. and exhaust this useful quantity of steam. From curve N, the maximum demand for steam is seen to be 7,600 lb. per hr.; at 31 lb. per kw.-hr. an engine will develop 245 kw. and exhaust this useful quantity of steam.

From curve C, Fig. 5, the minimum electrical demand is 195 kw. and the maximum is 435 kw.; there is, therefore, a deficit of 150 to 190 kw. during the summer months. A 200-kw. diesel-electric set would be large enough for this service, but it would be advisable to install a 250-kw. machine so that it could be used as a standby for either of the two uniflow engines.

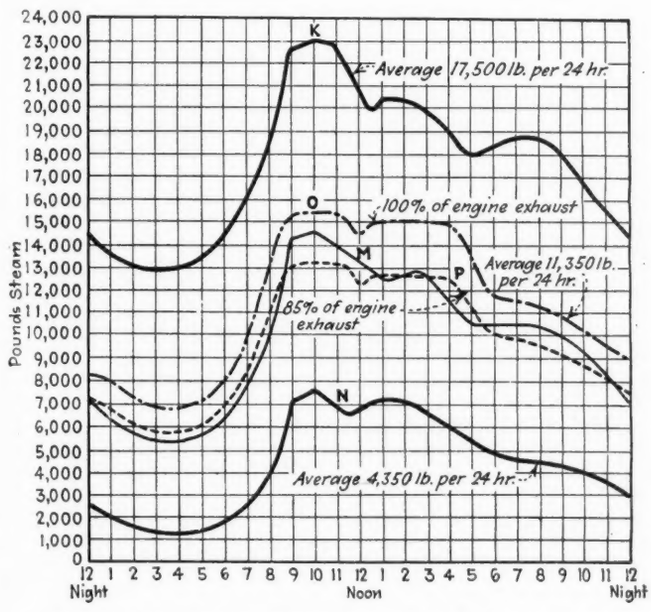


Fig. 10—Low-pressure steam demand and exhaust available (Scheme A)

For this scheme, the following have been assumed:

1. Steam conditions at the throttle, 150-lb. gage, 50-deg. superheat.
2. Four 2,000-sq.ft. boilers with oil-burning equipment.
3. Two 250-kw. vertical uniflow engines.
4. One 250-kw. diesel electric set.
5. Fuel oil, 18,000 B.t.u. per lb., 4c. per gal.
6. Boiler efficiency, 78 per cent.
7. Water rate of engines, 31 lb. per kw.-hr.
8. Fuel consumption of diesel, 0.441 lb. per hp.-hr.
9. Boiler feed temperature, 197 deg. or 165 B.t.u.
10. Heating system operating on 2 lb. gage pressure.

The amount of steam to be generated by the boilers under this scheme would be:

For the four winter months:			
Area under curve K	17,500x24x30x4	=	50,400,000 lb.
H.P. steam for kitchen	31,000x30x4	=	3,720,000 lb.
H.P. steam for laundry	24,000x30x4	=	2,880,000 lb.
			57,000,000 lb.
For the four midseason months:			
Area under curve R	325.5x31x24x120	=	29,000,000 lb.
Shaded area	25,000x30x4	=	3,000,000 lb.
H.P. steam for kitchen	31,000x30x4	=	3,720,000 lb.
H.P. steam for laundry	24,000x30x4	=	2,880,000 lb.
			38,600,000 lb.
For the four summer months:			
Area of curve N + 17½ per cent	4,350x1.175x 2,880	=	14,700,000 lb.
H.P. steam for kitchen	31,000x30x4	=	3,720,000 lb.
H.P. steam for laundry	24,000x30x4	=	2,880,000 lb.
			21,300,000 lb.

This is a total of approximately 117,000,000 lb. of steam per year. To evaporate this will cost $44,500 for fuel oil.

The diesel-engine set will develop 150 × 24 × 30 × 4 = 432,000 kw.-hr., which will require 315,000 lb. of diesel oil at 5c. per gallon, a total of $1,970 per year.

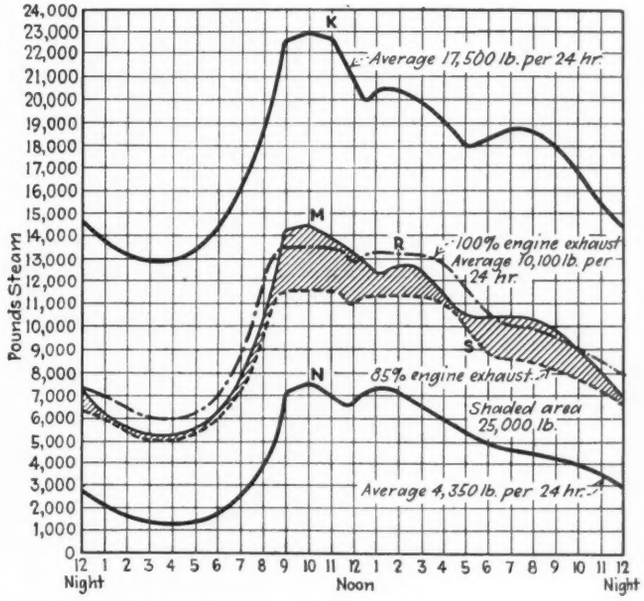


Fig. 11—Low-pressure steam demands and exhaust available (Schemes B & C)

Investment Costs

Four-2,000-sq.ft. boilers	$20,000
Four superheaters	3,000
Feed pumps and f.w. heater	2,000
Oil tanks, pumps, piping etc.	6,500
Breeching	1,500
Foundations	1,000
Two 250 kw. uniflow engine sets	40,000
Foundations	4,500
Piping	6,500
One 250-kw. diesel-electric set	19,000
Foundations	3,000
Erection	1,000
Diesel water cooling equipment	1,000
Diesel engine auxiliary	1,000
Diesel fuel tanks, pumps etc.	2,000
Switchboard and electrical connections	4,500
	$116,500

Operating Costs

	Per Annum
Interest, depreciation etc., 13 per cent	$15,150
Labor	14,000
Fuel oil	44,500
Diesel fuel oil	1,970
Lubricating oil	800
Make-up water	320
	$76,740

	Per Annum
Cost of operating with purchased power and steam	$136,000
Operating cost with boiler plant and steam engine and diesel sets	76,740
Saving	$59,260
Say	$59,000

Summarizing the various schemes and their indicated savings:

A. ..... $29,000 per annum
B. ..... $57,000 per annum
C. ..... $59,000 per annum

No account has been taken of the cost or space taken up by the smoke stack, because one should be incorporated in the building in any case as a precaution. Neither has breakdown service been included, as there is a spare machine provided.

As pointed out in the article on office buildings, the figures given may be considered as for an ideal case. To compare it with any one of the innumerable special conditions to be met in actual practice, it is only necessary to mention that, providing the investor is satisfied to pay for the equipment in five years, then for Case C, $23,000 per year of the savings must be considered as paying for the installation, and $36,000 could be lost in rental space occupied and additional investments in foundations or building changes before the individual plant would cease to be attractive.

To be perfectly fair to purchased power, it should be remarked that the electrical load curve developed on Fig. 5 does not include the energy which would be required to operate boiler feed pumps and fuel oil pumps for the oil-burning equipment. This is an extra load which is chargeable to the individual plant only, but it would not materially affect the final result.

The writer does not profess to be a hotel operator, but a few thoughts upon the engineering side of operation may be of interest.

At the beginning of this article, stress was laid upon the shape of the electrical load curves, so, referring to Fig. 2, taken from the proceedings of the N.D.H.A., it will be noticed that the electrical load curve is nothing like those developed on Figs. 3, 5 or 6. This the writer believes may be due to the fact that these curves on Fig. 2 were taken more than nine years ago, when perhaps, high-speed elevators, ventilation and other mechanical equipment were not stressed as much as they are today. The result is that the lighting predominates, especially as indicated by the peak around 7 o'clock. The shape of the steam curve of Fig. 2, however, resembles that of the curves on Figs. 8 and 9 fairly closely.

Referring to Fig. 1 again, it will be seen that although the average of the maximum winter and summer loads are almost the same for the two hotels, the average of the minimum values for hotel B is much lower.

If the reader will refer to the built-up graphs on Figs. 3, 5 or 6, he will notice that only the most essential equipment is run in the early morning hours. Therefore it would seem that hotel A was running some apparatus which perhaps could be shut down. This may not be the fault of the engineer in hotel A, it may be due to the way the equipment is laid out. For instance, there may be one large fan for ventilating the engine room and also the rest of the basement, and, inasmuch as the engine room must be ventilated 24 hr. per day, an unnecessarily large fan may have to run at all times.

The design of the equipment should, therefore, be considered in connection with the possible operation, and in general, relatively small individual fans should be used.

In closing, the writer does not pretend that he has solved such a complex subject as hotel operation and management, but he believes that he has presented a few thoughts which will prove of interest. His method of building up the electrical load curves will doubtless receive criticism, but he believes that it has some merit.

The writer also believes that it would be to the advantage of many hotel managers to have their properties looked over by outside consulting engineers with a view to effecting economies, for there are many opportunities sometimes overlooked by the operating force.

▼ ▼ ▼

Using Radiators for Building Cooling

By Gordon R. Hahn

In the March 29 number of *Power* there appeared on the "Readers' Problems" page an inquiry regarding the practicability of circulating cold water through radiators in order to reduce the temperature of a room or office during the warm months of the summer. On the whole, the answers implied that such a system would not be practical due to low heat transfer, poor air circulation and inconvenient condensation on the coils. However, there has been installed for some time a system of this type which has operated satisfactorily and economically.

An office of approximately 10,000 cu.ft. air space is being cooled by passing 10 gal. per minute through each of two coolers. The water used is cooled to slightly below 40 deg. by spraying it over ice contained in an insulated tank. Each cooler is equipped with a fan driven by a small electric motor, which creates an air circulation and improves the heat transfer. The condensing moisture drips into a pan that is connected to a drain pipe.

On extremely warm days, the temperature of the office has been reduced as much as 20 deg. below the outside air temperature by running the multi-speed fans at maximum speed.

Power consumption is increased only by the small amount of energy required by the circulating water pump, since the cooler fans have replaced the ordinary electric fans usually in service during hot weather. The ice consumption is not excessive, as the room temperature may be regulated automatically to any given extent.

Alternating-Current Motors for Elevator Operation

By C. P. HAMILTON
Industrial Engineering Department
General Electric Company

This article, although applying primarily to elevator motors, contains much that is useful in the general application of alternating-current motors in buildings. Such problems as the effects of starting current on voltage regulation, noise produced by motors and the effects of unbalanced voltage on this noise, and the use and control of multi-speed induction motors are some of the high spots

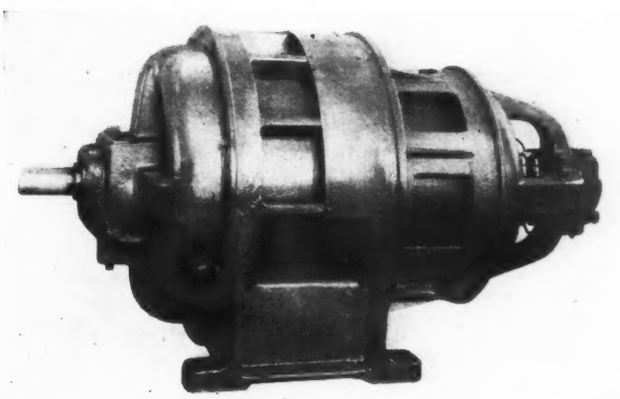


Fig. 1—Two-speed tandem induction motor, consisting of a slow-speed, squirrel-cage type and a high-speed, wound-rotor type

ALTERNATING current is the primary source of the power used for operating elevators in a large percentage of installations. In high-speed elevator service an alternating-current motor drives a variable-voltage generator that supplies direct current to the hoisting-machine motor. On the other hand, installations that can not justify variable-voltage equipment use alternating-current motors to drive the winding machine which, in practically all modern applications, is a geared traction unit.

Squirrel-cage type motors are generally used for elevators, but they must have special characteristics essential for this service. If the motor is driving a direct-current generator to supply a variable-voltage application, high pullout torque and quiet operation are desirable qualities, with low running-light losses to obtain economical operation. On the other hand, when alternating-current motors drive elevator machines, high starting torque, low starting current and a low noise level are the essential characteristics.

An elevator is primarily a torque application, as it consists of either raising or lowering a load with many starts and stops. The load may, due to the counterweighting, work either against the motor or with it in either direction of rotation depending on the amount of load in the car. Thus, the motor operates at speeds both under and over synchronous, as the loads vary from a motoring load to one that overhauls. It is, therefore, desirable that the motor's slip be kept within reasonable limits to avoid too great a speed variation between raising and lowering a full load in the car.

It is also necessary to develop high starting torque, as an elevator with full car load often requires as much as 225 per cent of rated full-load motor torque to break away from rest and to accelerate. The motor thus should develop approximately maximum torque when full voltage is applied. This means that the motor inherently will have a high slip. At this point, the starting current characteristic also enters the picture. A low-slip motor, obtained by reducing the rotor resistance, is an indication that the starting current will be high, as for an extreme example, the general purpose motor. On the other hand, a high-slip motor, resulting from increasing the rotor resistance to obtain the maximum torque at start, will have a low starting current.

Starting current (locked-rotor) is important from two standpoints: heating of the motor and its effect on the distribution system due to voltage dips. Since an elevator is continually starting and stopping, and also since heating varies as the square of the current, it is important that the starting current be kept low. However, there are certain minimum practical limits of actual starting current. The torque efficiency of a motor at its rated load is say 100 per cent. In other words, for 100 per cent of full-load current, it develops 100 per cent or full-load torque. However, during starting this ratio cannot hold, because of the increased magnetic leakage and saturation. Accordingly, with a well-balanced design the starting current and torque ratio approaches 400 per cent current to 250 per cent torque. In a few cases, and particularly in slow-speed motors, it may be practicable to build a well balanced design motor that will have a starting current as low as 300 per cent and develop 200 per cent torque.

These motors will generally have an exceptionally high full-load current. This means that, while the percentage full-load current may sound low, it will be just as high in amperes as a correspondingly rated high-speed motor with a higher percentage starting current. There is some tendency for purchasers of elevator motors to specify unreasonably low percentages of starting current to

develop a given torque even when specifying high-speed motors. The only way these low percentages can be met is by giving the motors a fictitious full-load rating which will give a low ratio of full-load current to starting current. Reputable motor manufacturers are unwilling to use such ratings.

Of course, in most cases the low-speed winding of a two-speed motor will have low starting current compared to the high-speed starting current due to its small horsepower rating. When the change is made from the slow-speed to the high-speed winding, the current peak will be comparable to that when starting from rest on the high-speed winding. If the transition current peak is held to say 200 per cent of full-load current, the motor will develop less than full-load torque and the elevator may not continue to accelerate, particularly if the load is working against the motor rather than overhauling it.

The other essential characteristic, a low noise level, is becoming more and more important. It is impossible to build a noiseless motor. An alternating-current motor is inherently a sound producer because of the pulsating nature of its torque—fundamentally changing 120 cycles per second in the case of 60-cycle power supply—and also because of other design features such as the ratio of the number of slots in the rotor to those in the stator. While every effort is made to make all the electrical energy put into the motor develop useful work, yet the losses run from 15 to 20 per cent, part of which at least are being dissipated in the form of noise, say, 1 per cent. This means that in the case of a 15-hp. motor 840 watts are used to make the machine noisy.

The average speaker in a large auditorium only uses about 100 microwatts of speech energy to make himself distinctly heard. If the 15-hp. motor in question were operated in the same room and if it were only a millionth as efficient in sound production as the vocal system of the human being, the speaker could not be heard above it. As a result of exhaustive study and research, however, motor designers are now able to build motors which are exceptionally quiet during acceleration, running and retardation, as compared to similar motors of a few years ago, and can be barely heard a few feet away.

While manufacturers in general are doing a good job in designing quiet motors, their good work can be largely offset by a small unbalancing of voltages between phases. As an indication of the effect of unbalanced voltages, the results of test given in the table may be of interest.

EFFECTS OF UNBALANCED VOLTAGE ON MOTOR NOISE

Voltage	120 Cycle Decibels or Loudness Units
Balanced	2
Unbalanced 5 volts	22.5
Unbalanced 7 volts	26

Since the sound intensity is doubled for each increase of 3 decibels, it will be seen that the 120-cycle frequency, which is generally the worst offender in traveling through a building structure, is increased in intensity nearly 128 times with 5 volts unbalance. Or expressing this in more general terms, with the motor placed on an insulated noise box, the 120-cycle frequency could not be heard in the box with the voltages balanced, but was plainly noticeable in the box with 5 volts unbalance.

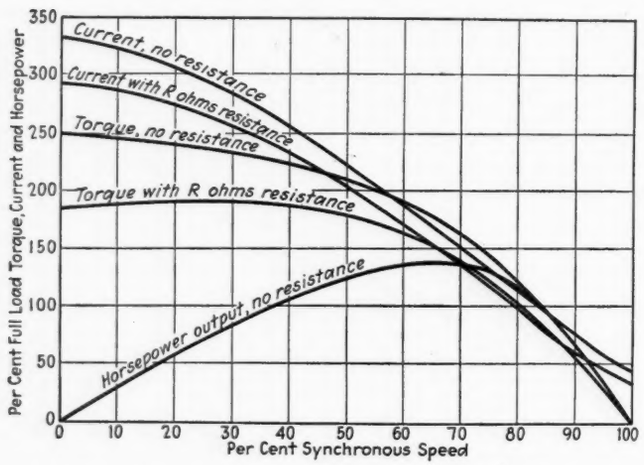

Current, no resistance
Current with R ohms resistance
Torque, no resistance
Torque with R ohms resistance
Horsepower output, no resistance
Per Cent Full Load Torque, Current and Horsepower
Per Cent Synchronous Speed

Fig. 2—Typical characteristic curves of a high-torque single-speed squirrel-cage motor when started with and without primary resistance

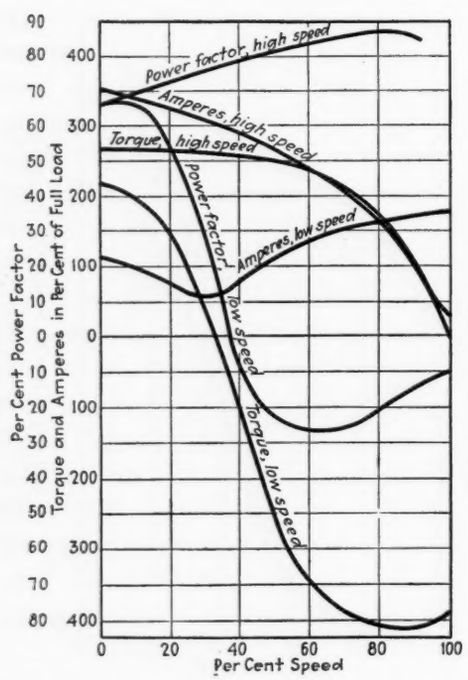

Power factor, high speed
Amperes, high speed
Torque, high speed
Power factor, low speed
Amperes, low speed
Torque, low speed
Per Cent Power Factor
Torque and Amperes in Per Cent of Full Load
Per Cent Speed

Fig. 3—Typical characteristic curves of two-speed squirrel-cage motors

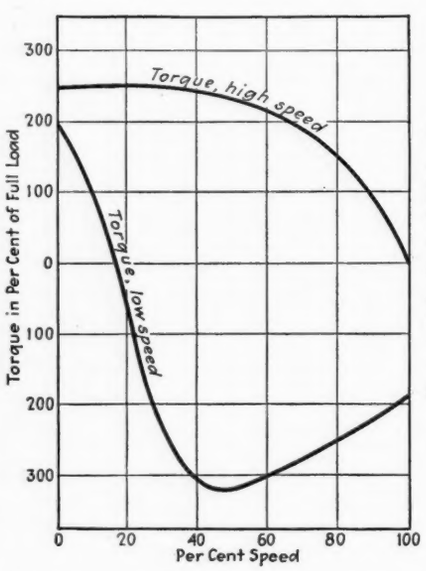


Fig. 4—Speed-torque characteristics of 6 to 1 speed ratio squirrel-cage motors

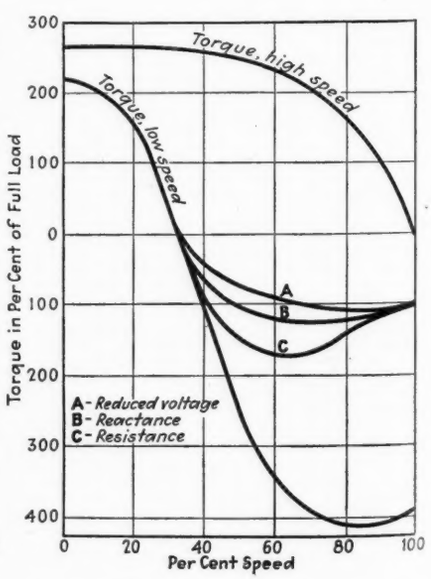


Fig. 5—Curves show effect of resistance, reactance and reduced constant voltage

Cork, rubber and other materials of various trade names are often used to isolate the motor or its support from the building. Their purpose is to keep the small amount of 120-cycle frequency vibration that the motor may develop from traveling into the building structure and possibly being greatly amplified by the floor slabs or walls.

Squirrel-cage motors may be divided into single-speed and two-speed types. The single-speed motor is only used for slow-speed elevators, that is, speeds usually less than 175 f.p.m. In fact, good engineering and operation dictate that they should be confined to speeds of 125 f.p.m. or less.

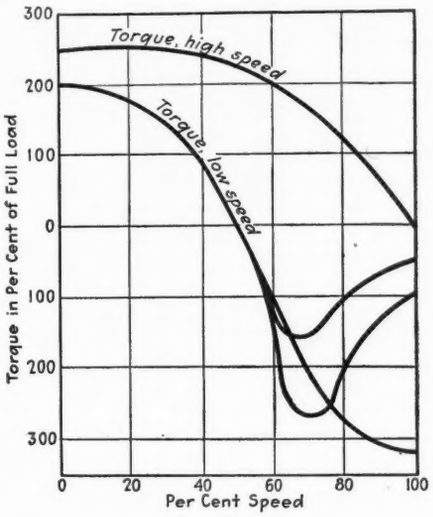


Fig. 6—Speed-torque curve of a 2 to 1 speed ratio motor to show effect of primary resistance on the super-synchronous torque of the low-speed winding

Stopping from high-speeds frequently make it necessary for an operator to inch the car to get it sufficiently level with the door sill. Thus, not only is the service poor and good landing stops difficult to make, but heating of the motor is greatly increased. Typical characteristic curves of a single-speed motor with and without primary resistance are shown in Fig. 2.

The two-speed type of squirrel-cage motor is built in ratios of 2 to 1, 3 to 1, 4 to 1 or 6 to 1. Higher ratios may be built, but due to the large number of poles required in the low-speed windings, the physical size of the motor becomes excessive for the output. It also becomes increasingly difficult to obtain quiet operation at slow speed and during retardation. The power factor on the slow speed winding is very low and the motors are difficult to keep cool. These motors have two separate windings in the same slots. They are so designed that there will be no circulating current in the windings due to transformer action should the winding not energized be short-circuited as is done in some control systems. The windings are usually star connected with both ends of each winding brought out to permit inserting resistors in the neutral connections. A typical set of characteristic curves is shown in Fig. 3. These curves cover a 3 to 1-speed ratio motor. The shape of the low-speed torque curve changes for various speed ratios, as will be noted by referring to the characteristic curve of a 6 to 1 speed ratio motor, Fig. 4.

The squirrel-cage motor, either single speed or two-speed types, seldom gives trouble due to overheating when applied to average elevator operating conditions. When the starts per hour are excessive, as may be the case with elevators serving department stores, and when the operating speeds are high, overheating may result with this type of motor. The reason is that it must dissipate, internally, the accelerating losses as well as the full-speed losses which are relatively high due to the slip.

Another type of two-speed motor has been developed for severe elevator service. This machine consists of a high-speed slip-ring induction motor mounted with a low-speed squirrel-cage motor, Fig. 1. The slip-ring section is used for acceleration and full-speed running, while the squirrel-cage section provides the landing speed. Since the acceleration losses are largely dissipated externally in a resistor, and as the motor has a low slip, its full-speed losses are correspondingly low. This type combination motor, or tandem motor will stand a large number of starts per hour without overheating, and is built for 4 to 1 and 6 to 1 speed ratios.

Control of Two-Speed Motors

In the control of two-speed motors, the problem is largely one of obtaining smooth operation. This has largely been solved during acceleration by using the high-speed winding entirely for this purpose with properly designed resistor steps either in the neutral or line side. Smooth retardation, on the other hand, is more difficult to obtain under all the load conditions that the motor is subjected to. If the control is arranged to switch to the low-speed winding with full voltage, it will be noted by referring to Figs. 3 and 4, that the torque obtained above synchronous speed will result in very severe or rough retardation. It is, therefore, necessary that some means be used to soften the initial torque change and yet obtain sufficient torque to give a reasonably rapid retardation to avoid the sensation of floating and loss of time. The most common method used is to insert buffer-resistance steps in the low-speed winding and in some cases resistance is inserted in the high-speed winding during the transition to slow speed.

In Fig. 5, curve *C*, is an indication of the shape of the super-synchronous torque characteristic obtained with a resistor laid out to give 100 per cent torque at throwover from the synchronous speed of the high-speed winding of a 3 to 1 ratio motor. The shape of this curve changes, however, with different ratio motors in such a way that the higher the ratio, the deeper the valley becomes. Also, in some cases, such as 2- to 1-ratio motors with low values of resistance, the torque curves may actually cut somewhat to the left of the fundamental curve, as may be noted in Fig. 6. Therefore, resistors must be carefully selected for each particular motor and most likely require adjustment after installation to obtain the best results due to the loading and inertia of the elevator system.

The effect of using reactance instead of resistance is shown by curve *B*, Fig. 5, and the use of a compensator to give reduced constant voltage is shown by curve *A*. One advantage of the compensator method is that a smoother transition to low speed may be obtained than when resistors are used, particularly when the throwback is made before full speed is reached. However, an apparent disadvantage is that retardation will not be as rapid as may be desired without too high a value of throw-over torque; in other words, the rate of retardation decreases as the speed decreases.

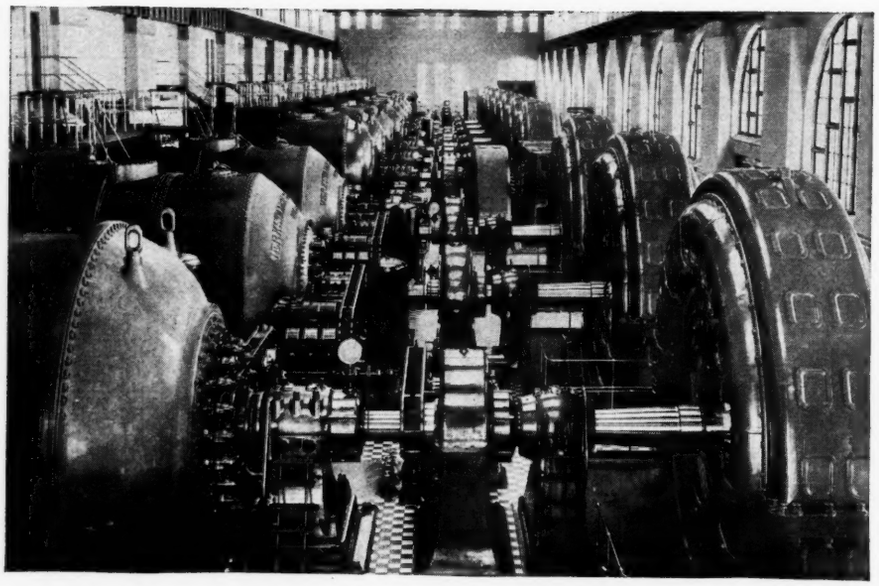


Fig. 1—Interior of Trollhättan hydro-station that is being modernized to increase its capacity and improve efficiency

Modernizing Trollhättan— Sweden's Largest Hydro Plant

Rebuilding a 12,500-hp., horizontal-shaft francis-type turbine operating under a 100-ft. head increased its maximum rating to 17,800 hp. and raised its efficiency from 86 to a maximum of 91.6 per cent

By GEORGE WILLOCK

Engineer
Nydquist & Holm, A.B.

TROLLHÄTTAN power plant is the largest of Sweden's hydro-electric plants. It is owned by the Royal Board of Water Falls, is located on the Gotha River about 8.75 miles below Lake Vänern and 47 miles up the river from Gothenburg, and is now being rebuilt to obtain increased output and efficiency. A gross head of 103.5 ft. is obtained at the plant. To the thirteen main units the penstocks have a diameter of 14 ft. and are from 215 ft. to 230 ft. long. The penstock to the three auxiliary units is 4 ft. in diameter.

The first four units were put in service in 1910 and the last unit in 1920. The complete plant then consisted of eleven horizontal-shaft double-runner francis turbines, each rated at 12,500 hp. at 187.5 r.p.m., two horizontal-shaft double-runner francis turbines of 13,200-hp. capacity each at 187.5 r.p.m., all direct-coupled to alternating-current, three-phase generators. Eight of these generators were rated at 11,000 kva., 11,000 volts, 25 cycles, and three at 11,000 kva., 11,000 volts, 50 cycles. The other two units consist of two three-phase generators, one for 25 cycles and one for 50, each rated at 13,500 kva., 11,000 volts. There are also installed for lighting, excitation and auxiliary machinery three horizontal-shaft single-runner 500-hp. francis turbines directly coupled to 350-kw. direct-current, 220- to 300-volt generators.

A few years ago the question arose regarding the possibility of increasing the output of the older units. After careful investigation by engineers of the Royal Board of Water Falls it was decided to modernize machines Nos. 3 and 4. The output was to be increased from 12,500 to 16,000 hp., at the same time increasing efficiency. This alteration was carried out in 1930 and gave the results expected. At that time Nydquist & Holm, Ltd., received an order to modernize unit No. 5, and it is this machine that will be considered in this article.

To make sure that the expected results would be obtained, a model of the turbine, complete with pressure casing and draft-tube, was constructed and tested. Results obtained from the tests of the model were such that the replacement of unit No. 5 was undertaken to obtain a considerably higher capacity and efficiency than that originally anticipated.

On the old and new units, the pressure casing is similar, with the exception that one end-cover has been moved about 10 in. and a distance piece inserted, due to the over-all length of the new unit being slightly greater

than that of the old one. There is a bearing and inspection chamber inside the draft-chest of the old unit, Fig. 2, but in the new machine, Fig. 3, this has been omitted and an unobstructed passage is obtained for the water's flow.

The old runners were of cast-steel, with nineteen steel-plate buckets each, and had a diameter of 5 ft. 11 in. The new runners are 6 ft. 4 in. in diameter and are of cast-steel with eighteen buckets of stainless steel plate. There were twenty gates for each of the old runners, with a height of 21.5 in., as compared with the same number, 25.5 in. high, in the new unit. The regulating mechanism for the old unit was of the external type, while those newly installed are of the internal design. The former was placed in the inspection chamber for the rear runner and outside the end cover for the front runner.

A large part of the output developed by this plant has a frequency of 25 cycles, but in the modernization of the plant it has been decided to install more 50-cycle machines. The modernized generator consists of a double unit, comprising the existing 11,000-kva., 25-cycle generator combined with a new 16,500-kva., 50-cycle generator. This entailed a new hub and shaft for the old unit, new bearings and a new exciter. The latter is a chain-driven double unit, one exciter for the 25-cycle generator and the other for the 50-cycle generator.

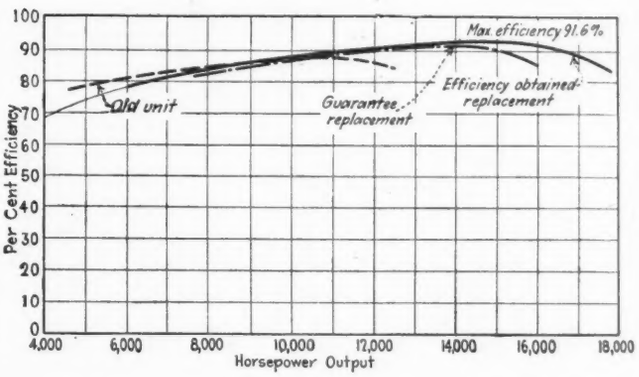


Fig. 4—Housepower-output efficiency curves for the old and the new turbine

EFFICIENCIES AT DIFFERENT HORSEPOWER LOADS OF THE OLD AND THE NEW UNIT

Old Unit		New Unit			
		Guaranteed		Obtained by Test	
Output, Horsepower	Efficiency, Per Cent	Output, Horsepower	Efficiency, Per Cent	Output, Horsepower	Efficiency, Per Cent
12,500	82.3	16,000	85.0	17,800	83.0
12,000	85.0	15,000	89.5	17,000	88.0
10,000	86.0	14,000	90.5	16,000	91.0
8,000	84.0	12,000	89.5	15,000	91.6
5,000	77.5	10,300	87.0	14,000	91.4
		8,000	82.0	12,500	90.6
				12,000	90.2
				10,300	88.0
				8,000	83.5

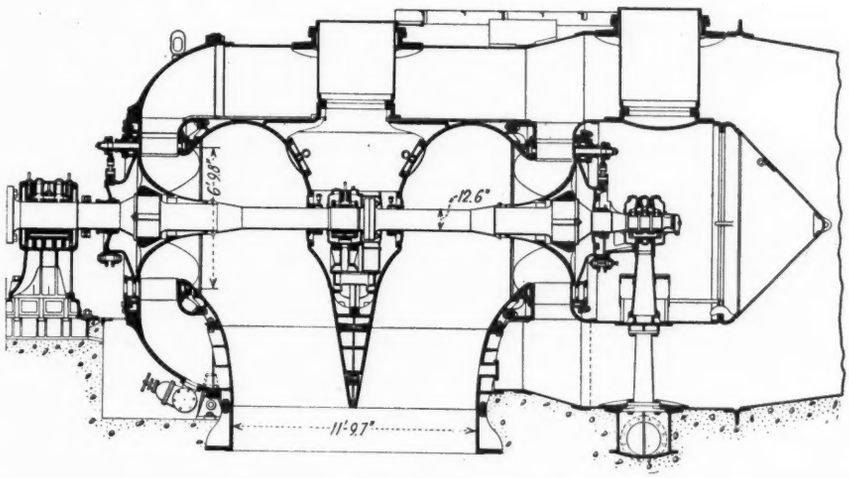


Fig. 2—Cross-section of the old 12,500-hp. turbine

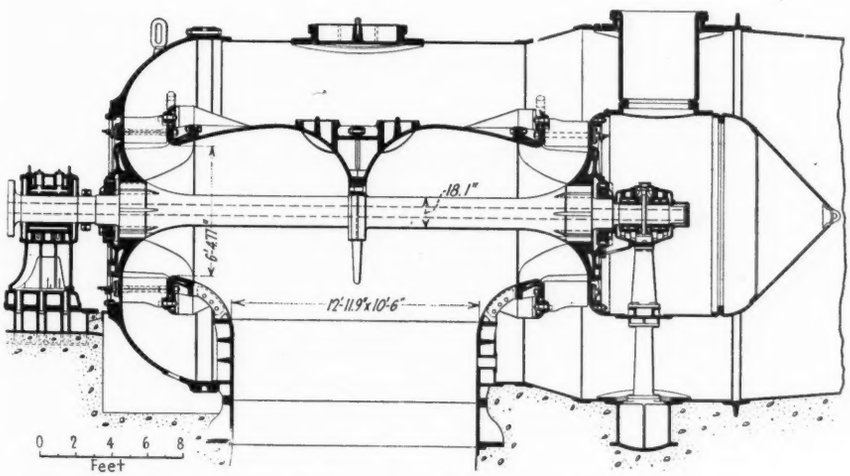


Fig. 3—Cross-section of the new 17,800-hp. turbine

The generator shaft is designed to transmit 18,000 hp. The new generator was supplied by the Swedish General Electric Company, which also made the electrical alterations to the unit.

Replacement of the unit was completed in the latter part of 1931. Official tests were then made. Fig. 4 and the table shows the outputs and efficiencies of the old unit and the guaranteed and test efficiencies obtained for the rebuilt machine. The water was measured by seventeen current meters placed in the penstock. As can be seen the output is considerably in excess of that contracted for, and the efficiency obtained is in excess of that guaranteed, at all loads. An output of 1,780 hp. more was obtained than guaranteed and the maximum efficiency, 91.6 per cent was 1.1 per cent higher than expected.

If a comparison is made between these results and the outputs and efficiencies of the old unit, it is found that the gain in efficiency at a load of 12,500 hp. means that an output of 13,800 hp. can be obtained with the same quantity of water going through the new unit.

The output of the unit has been increased, a total of 5,300 hp., as a result of the excellent performance obtained. Orders have been placed to rebuild four more machines. This means that the gain in output obtained from these five units and re-

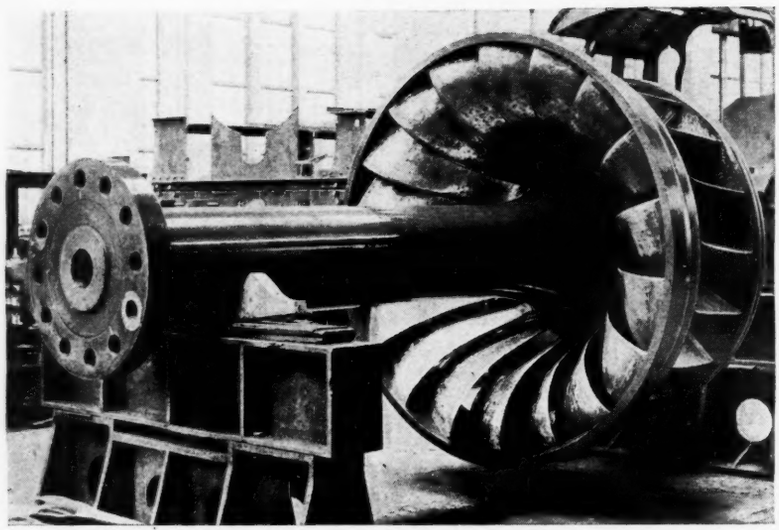


Fig. 5—The new runners have 18 stainless-steel plate buckets cast into a steel hub and band

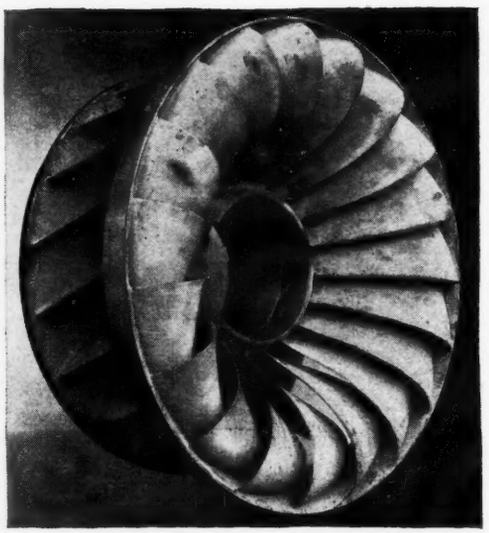
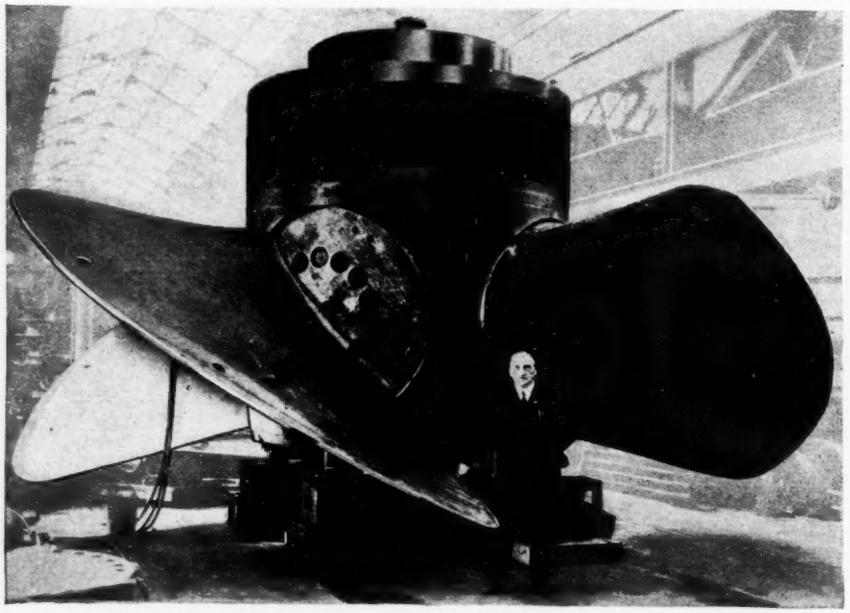


Fig. 6—The old runners had 19 plate-steel buckets

built units 3 and 4 previously mentioned, will be 33,500 hp., increasing the total output of the plant from 163,900 to 197,400 hp. It is possible that three more units will be replaced later and in that case the total output will be 213,300 hp.

When it is considered that practically all of the Trollhättan plant's output is primary power, and that the water supply can be regulated throughout the year, the economical gain resulting from rebuilding the units is easily understood, when the turbines replaced are 20 years or more old.

When the replacement was planned it was calculated that the existing oil-pressure governors would be able to regulate the new unit. If the full-load output had been 16,000 hp. or slightly more, the governor would have had sufficient capacity. Due to full-load output being so much in excess of that value the governor was too small. This has been corrected by fitting an extra auxiliary servomotor on the governor, at a small cost.



Runner for one of Swir-III turbines which will develop 37,500 hp. under a head of 30.5 to 36 feet

Swir-III Kaplan Turbines Largest Constructed

The photo below, taken at Verkstaden, Kristinehamn, Sweden, works pictures the runner for one of the turbines to be installed in the Swir III power station in Russia. This runner will hold the record for some time as the largest diameter unit of the Kaplan type. Swir III station is on the Swir River, between Lakes Onega and Ladoga, the latter being near Leningrad. Head will range from 30.5 to 36 ft. Four identical units each will develop 37,500 hp. Runners are 24.35 ft. in diameter, as compared with the 18-ft. 4 in. runners in the Safe Harbor plant on the Susquehanna River. The latter, designed for a head of 55 ft. and to develop 42,500 hp., have the highest capacity of any Kaplan type.

Blades on the Swir runners weigh 10.5 tons each and are made of Swedish stainless steel. Extensive tests at Verkstaden, Kristinehamn, have proved that this material has greatest resistance to pitting due to cavitation. The Swir III runners will be exceeded in size by those being built for the Vargon power station in Sweden. The latter will be 26 ft. 3 in. in diameter and are rated 15,200 hp. under 14-ft. head.

The servomotor for shifting the runner's blades is built into the hub which is also in other respects designed according to the Englesson patents. Standing by one of the runner blades in the picture is the well known Russian engineer, Prof. Henry Graftio, who built the Volhov power station and is now chief engineer of Swir III plant.

Information and photo for this article were supplied by Elov Englesson, Chief Engineer, A-B Karlstads Mekaniska Verkstad, Verkstaden, Kristinehamn, Sweden.

Metering and Injection In High-Speed Diesels

By ALAN CRAIGON

APPLICATION of the diesel engine for driving buses, trucks and automobiles brings up the problems of space and weight limitation even more acutely than in the diesel railcar and locomotive fields. It likewise brings up the problems of oil-combustion rapidity, flexibility and also what is sometimes termed "fuel calibration," that is, the metering out of infinitesimally small quantities of oil per working stroke with great precision and exact timing capable of variation at will as in the advance-and-retard operations common to electrical ignition engines. Certainly, flexibility of the engine throughout a wide speed range is indispensable if the diesel is to compete successfully against existing gasoline engines.

The author has repeatedly heard it said that the diesel engine will never be a competitor in these small power fields due to its inherent lack of flexibility. Some claim that it is difficult, if not impossible, to drop the speed of a diesel down to, say 10 per cent of the full-load speed and then as suddenly return to full-load values again, a practice constantly resorted to in automobile work, especially through traffic. The objection is made that the diesel coughs and splutters at low revolutions and shows a marked reluctance to speed up when the accelerator is depressed suddenly. This is difficult to understand, if true, because the working gases in a diesel engine cylinder during combustion and expansion contain much more internal energy than those in a gasoline engine.

Intricate attempts have been made to correct this lack of flexibility, mainly on the assumption that the root of the trouble lies in the varying rate at which work is done in compressing the air in the cylinders at various speeds. The point is made that at low revolutions the rate of work done on the air is lower and the final compression pressure and temperature for a given apparent compression ratio is not high enough to insure cold starting and satisfactory ignition of the oil at the low speeds. Further, it is said that an increase in calculated compression ratio, while correcting the starting and low-speed conditions, would so increase the maximum pressures and temperatures at full-load speeds that the engine would have to be constructed much more robustly to withstand them.

An engine supposed to correct this condition is shown in Fig. 1. The exhaust ports are provided with what might be called a secondary exhaust valve automatically varied as to timing so that at low revolutions it closes, say, at bottom piston dead center, in which case compression would start at bottom dead center. When the speed increases towards full-load values, closing of this valve is more and more delayed, thus decreasing the volume of air compressed, with the result that at a full-load speed compression might not actually start until the exhaust ports are re-covered by the piston. In this way the compression ratio of such an engine at, say, 200 r.p.m., might be 18, gradually decreasing automatically until, say, at 2,000 r.p.m. the compression ratio might only be 12. There seems to be some merit in this idea, and it no doubt does influence combustion, starting and general flexibility. The same principle of variable compression has been employed on four-cycle high-speed engines.

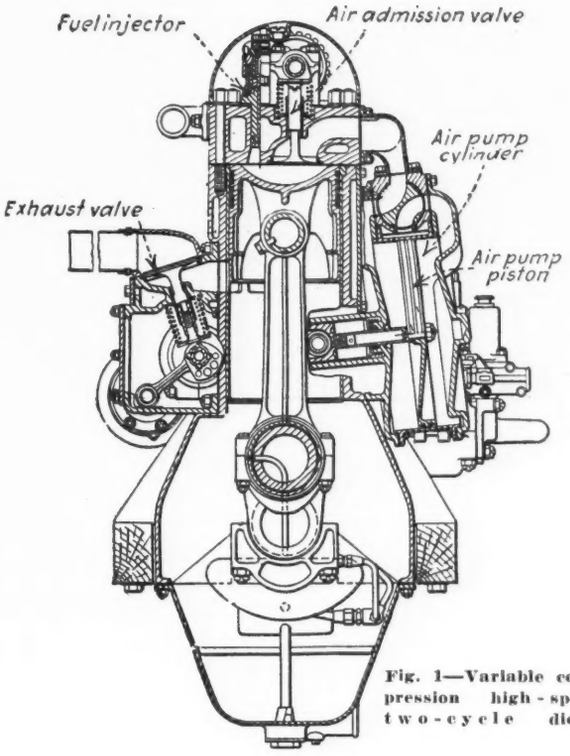


Fig. 1—Variable compression high-speed two-cycle diesel

Compression trouble, however, is not the sole cause of "spluttery" operation at low speed. As air-blast oil injection, in which the oil is forcibly blown into the cylinder by means of high-pressure blast air, is rapidly disappearing, this problem will be considered from the standpoint of mechanical, or solid, injection.

The fundamentals of oil pulverization in diesel engines are that a small fuel-measuring reciprocating-plunger pump takes in oil on its suction stroke and then discharges it at high hydraulic pressures through a needle point hole or a series of holes in the spray nozzle of the fuel injection valve. These valves are, in principle simply spring-loaded needle valves. Good combustion, on which depends the efficient production of working pressures, will depend either upon getting every particle of oil into the presence of sufficient oxygen to enable it to burn completely, or conversely, on bringing enough

oxygen to each particle of oil to effect the same end. There are two principal methods by which this can be done: either the oil must be atomized and the spray so diffused as to come into contact completely with all the available air in the combustion chamber at the time of injection, or if the jet or spray is merely atomized but no attempt made to shape the spray, the available air must be brought in some manner around all sections of the oil spray. The first method is called the *penetration* method and the second the *turbulence* method.

Irrespective of which method is used, the oil spray must evidently not come into contact with the metal of the combustion chamber as it sticks and carbonizes upon the metal. Penetration is usually effected by arrangement of the number, size, shape and direction of the holes in the spray nozzle to cause the oil spray to expand in every direction and thereby to saturate all the available air with small oil particles. As everyone is familiar with the conical shape of a high-velocity jet issuing from an orifice, one can visualize difficulties in obtaining complete penetration while maintaining a good combustion-chamber shape.

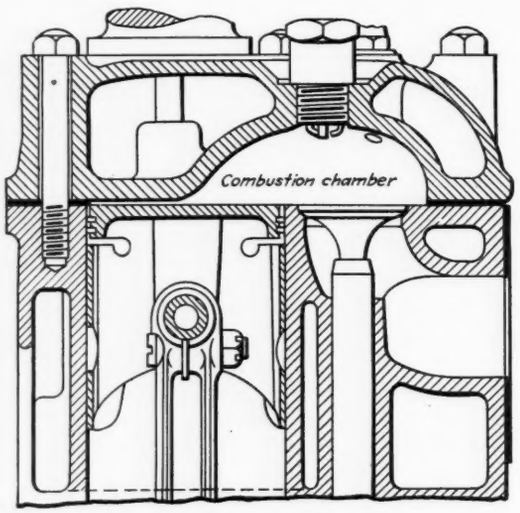


Fig. 2—Ricardo cylinder head

In the turbulence method, some plan is usually adopted to cause the air to take a regular defined whirling path past all sections of the spray. The well-known Ricardo head, now also used in diesel engines for turbulence produtcion, is shown in Fig. 2. The last layers of air or gasoline vapor, as the case may be, are squeezed between the up-traveling piston and the cylinder head and sprayed into the pocket-type combustion chamber in the cylinder head. This Ricardo head has been very successful, although strangely enough, when the author designed it about twelve years ago it was roundly condemned on the grounds that the shape presented too great an area for the escape of the heat from the working gases.

Experiments conducted since have proved that even the worst forms of combustion chamber known today cause no more than 6 per cent maximum loss of the net heat liberated due to heat loss through the cylinder walls and heads, and, as a matter of fact, probably the largest percentage occurs through the walls during the expansion and exhaust strokes, because the time element throughout these periods is much longer than that during actual combustion. This might be debated, however, because although the time element is shorter during combustion, the gas temperatures at this time are very much higher than they are later on in the stroke. Thus the temperature gradients are also higher, whereas the converse of these conditions exists throughout the actual gas expansion part of the stroke.

Turbulence is vital in the diesel, but not as much so as in the gasoline type engine because the flame rate in the latter is entirely dependent upon a mechanical carriage through the whole mass of gas of the ignited mass adjacent to the spark plug points. In the diesel, turbulence should be regarded simply as a means of bringing air to the oil, which, of course, has its effect on rapidity of combustion, but for different reasons than those found in the explosive vapor engine. The equivalent of the diesel's oil penetration is to be found in the gasoline engine's carburetion.

Either or both penetration and turbulence may be effected in the diesel engine, but their influence on poor combustion and imperfect firing at low revolutions, in the author's findings, is less important than is generally thought. The effect of speed on final compression temperatures also is less important than would appear on first inspection.

The key to the problem is varying fuel-pump speeds accompanied by varying spray velocities, resulting in varying degree of pulverization efficiency. This in turn causes varying combustion efficiency with consequent variations in the working pressures developed. The rapid decrease in diesel thermal efficiencies at lower loads is a further result of poor atomization, with its train of evil effects on the engine generally.

On account of injection-timing requirements, fuel measuring pumps, such as the well-known Bosch pump, Fig. 3, are all driven direct from the engine, so that as the engine speed varies so also does the plunger-travel velocity in the fuel pumps. That is, for constant plunger stroke the plunger's speed in feet per minute varies directly as the engine revolutions per minute. The rate of discharge from the fuel pump will follow naturally all such increments and decrements in plunger speed, and this will cause a corresponding result in the spray nozzle.

As pulverization is produced simply by the rate at which oil is forced through the spray nozzle holes, pulverization naturally suffers as the engine revolutions drop, soon reaching a value where the oil particles are too large for rapid, complete combustion. The author has heard two-cycle engines condemned on account of irregular firing at high speeds, supposedly due to the short period of time for exhausting and recharging the cylinders, yet just as erratic firing was encountered at the lowest speeds at which the explanation would no longer hold. Further, with an increase in supercharging pressure at the lowest speed in these engines, no appreciable improvement was shown in firing regularity or perfection of combustion. In one case, arrangements were made artificially to control spray-nozzle velocities, with immediate improvement at low revolution, of firing regularity, combustion and horsepower output. An injector velocity increase throughout the entire speed range resulted in marked improvement throughout and an almost total elimination of afterburning.

Another noteworthy point against present spring-opposed needle-valve types of injectors is the chattering action found in the oil-pressure diagrams taken from

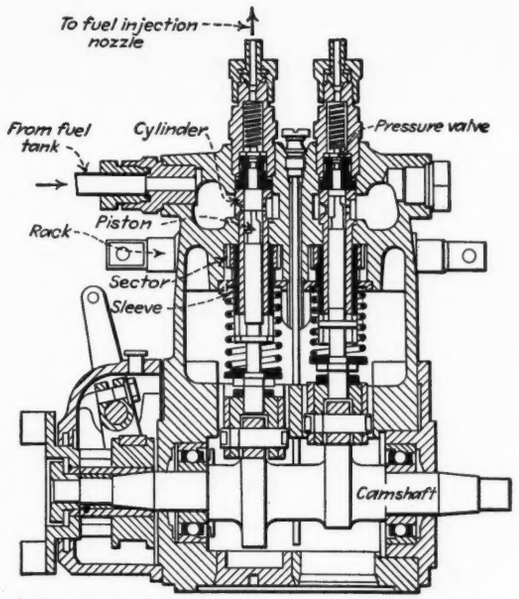


Fig.3—Bosch fuel distribution pump in longitudinal section

the body of the valve. The oil may be at maximum pressure just prior to the opening of the needle, but the moment the needle moves off its seat there is an immediate lowering of pressure due to the displacement change that occurs in the valve body. For a fraction of a second high pressure and high velocity may exist. Both immediately fall, however, due to removal of displacement resulting from the needle withdrawal from its seat. The needle valve consequently bounces back onto its seat, thereby cutting the fuel injection momentarily until the fuel-measuring pump brings the oil pressure in the valve body high enough to lift the needle once more. This, again, is immediately followed by lost displacement and another bounce of the needle onto its seat. Thus, although the fuel-pump cam drive may be of such a contour as to produce theoretically uniform plunger velocity throughout the working range of injection, the actual injection itself takes the form of a series of pulsations of greatly varying velocity, with a low mean velocity. It is, therefore, not to be expected that the spring-loaded needle-type injector used almost exclusively today, in solid-injection engines, will have firing conditions conducive to the regular firing in diesel engines that is obtained in gasoline engines. The subject still requires a great deal more research.

With constant velocity spraying throughout the entire period of each injection, maintained throughout the active speed range of an oil engine, there is definite promise of just as good flexibility with diesel engines as in the present widely used gasoline engine.

▼ ▼ ▼

Some New Engineering Problems*

By CHARLES F. KETTERING

Vice-President, General Motors Corporation

TWENTY-FIVE million generating stations are operating in the automotive industry today. True, they are small, only about 100 watts apiece, but yet they total two and a half million kilowatts. We have a large excess of power, of course, in our engines, something like a couple of billion horsepower, and more than that if you believe advertisements. . . .

Now the subject of research has had a lot of discussion. I have often thought of "research" as a word used primarily as an advertising medium, but it had a real fundamental meaning. I used to try to interest people in what was meant by research, and I coined a definition that research was a means of keeping everybody reasonably dissatisfied with what they had. That was objected to by our advertising and by other advertising people because they said a satisfied customer is the greatest advertisement you have. I admit all of that, but he is also the poorest customer, too. . . .

One of our problems today is our faith in the sureness and positiveness of standardization. However, in the standardization of things that we have done, we have not recognized that the present, immediate economies which have resulted from standardization sometimes have an entirely different effect. In other words, it is like the musician who "blows the note in sweet and it comes out sour." That is due to the fact that we do not recognize that we are dealing with positive quantities when we are dealing with human relationships. We are dealing with likes and dislikes; therefore cold statistics sometimes fail.

I have no objection to the standardization of this and that or the other thing that has to do with the specific thing, but I do have an objection to the standardization of ideals, to the standardized method of thinking and to the standardizations which overlap so that you cannot make one without changing a half-dozen others. I do not know why it is that in this construction period of the last 25 or 30 years we have become positive that there is only one way to do a thing. We have become positive that these standards represent all that there is to be attained. I do not believe that. I do not believe that anything we have today is so very good.

Now why do I say that? I'm going to tell you just one little story. We were interested in studying bearing pressures, not of the usual 6,000 lb. per sq.in., but of 600,000 lb. per sq.in. Well, there wasn't any book that went that far. Consequently we had to conduct some experiments, and I have found that in trying to experiment in an old industry that you had better have some fellow try it who does not know anything about the industry. So we put a man on this job who didn't understand lubrication, and we said to him, "Now here is quite a problem. We are talking about a thousand times more pressure than we have been used to dealing with." Well, to make the story quite short, he made a simple experimental machine in which we could try out the various types of lubricants and materials. None would apparently meet the requirements at all specifications. We applied them to this machine with very much temerity and very much sureness of failure. The same auto bearing that had carried 6,000 lb. to the sq.in., if doped with a little bit of Pyrene from the fire extinguisher on the wall, carried 30,000 lb., and didn't seem to recognize itself as under pressure at all.

I am mentioning that for the simple reason that I doubt whether I could have gotten a good, honest lubricating engineer to put Pyrene in his lubricator.

*Abstracted from a paper presented before the N.E.L.A. convention, June 5-10.

Rationalizing Fan Selection

By CHARLES A. CARPENTER
Pittsburgh, Pa.

Not all the factors which influence fan application are subject to mathematical analysis, therefore errors may develop even though the engineering analysis is of the best. These errors may be kept within practical limits by a few obvious steps

MANY factors influence proper fan application, some of which are not subject to a perfect mathematical analysis. It, therefore, follows that under ideal circumstances with the best of engineering analysis, errors may develop. However, these errors may be kept within practical limits by adherence to a few more or less obvious steps.

In the first place, it is important to know if the fan will actually perform as claimed. If reliance cannot be placed on the performance characteristics, certainly no amount of study or theorizing will make a "wrong" fan perform "right." Therefore, in selecting fans, it is essential to know whether or not the fan offered is rated in accordance with adequate and accurate tests. It also follows that manufacturing processes at the plant manufacturer must be controlled so that fans, supposedly duplicates, are duplicates in fact and will perform as claimed.

Many engineers overlook the fact that a fan must develop sufficient pressure differential to overcome all resistances encountered, plus a sufficient velocity pressure to maintain the rate of flow. Unfortunately, few fan applications involve uniform constant velocity throughout the path of the air or gases handled. Therefore, calculations must be made to determine pressure losses due to changes in velocity. This brings one to the crux of the whole fan problem, namely, calculation of the required pressure.

Safest to Calculate Step By Step

A logical approach to the problem involves a clear mental picture of the work to be done. It is much safer to make calculations, step by step, beginning at some definite point as, for example, the fan outlet, the stoker, wind box, an indirect heater, etc. Then, unit by unit, pressure losses should be computed until the entire air or gas path has been included.

While making calculations, attention should be paid to changes in temperature; to the influence of favorable or adverse stack effect due to changes of duct elevation, if temperatures are high and changes of elevation are great as in power house applications; sudden changes in velocity; bends, elbows, etc.; and to losses through apparatus.

It is well to bear in mind that pressure losses through apparatus are difficult to obtain accurately. Likewise, duct, elbow and orifice losses are generally estimates. However, if reasonable care be exercised, it is possible to set up a tabulation for each required rate of flow, giving maximum and minimum total pressure requirements. While making such calculations, attention should be paid to the maximum and minimum requirements of volume to meet the needs of the job. In other words, every fan problem worth studying has two sets of limits: maximum and minimum volume for each chosen condition, and maximum and minimum pressure to cause these volumes to flow. Somewhere between these limits the fan must perform. How closely these limits may be brought together is the measure of the quality of engineering done.

Assume that reliable curves with readable scales are available, showing how a proposed fan is expected to perform. Such curves must be based on some definite standards such as dry air at 70 deg. F. and 29.92 in. of mercury. Corrections can then be made, bringing the requirements in harmony with the fan curve standards, or vice versa. It is generally assumed that a fan will perform as to volume with definite volumetric efficiencies,[1] regardless of gas density, whereas the corresponding pressures will vary with the density and horsepower will vary accordingly.

Pressure Varies as Square of Gas Flow

In most fan problems, it is assumed that for fixed air path conditions the pressure varies directly as the square of the quantity of air or gas flowing. Algebraically, $Q^2 = KP$ in which Q represents cubic feet per minute (C.F.M.) flowing, K is a constant dependent upon the size, shape, material and construction of the air or gas path and P the pressure in inches of water gage (w.g.).

It follows that $Q/\sqrt{P} = \sqrt{K} =$ a constant.

From a performance curve sheet with cubic feet per minute as a base and pressure in inches, efficiency and brake horsepower as ordinates, it is possible to construct a curve showing the relation between C.F.M. (the base scale) and $Q/\sqrt{P}$ (calculated from the pressure-volume characteristic). Such a curve is shown in Fig. 1 for a typical forward curved vane ventilating fan. Figs. 2 and 3 show similar curves for radial tip vane and backward curve vane fans, respectively.

Referring to a tabulation of maximum and minimum pressure-volume relations first mentioned for the system the fan is going to serve, for each set of assumed conditions reduced to the same standard conditions as

[1]Expressed as a percentage relation between the actual volume delivered per minute and the product of the cubical contents of the fan wheel multiplied by the revolutions per minute.

these curves, one can calculate the corresponding $Q/\sqrt{P}$ values. By inspection, corresponding volumes and efficiencies may be read from the curves, Figs. 1 to 3.

Since for fixed air path conditions the volume delivered varies directly as fan speed, comparing the volumes determined by the $Q/\sqrt{P}$ calculations and curves with volumes desired readily permits calculating the necessary changes in revolutions per minute. Likewise, this comparison tells almost at a glance if the proposed fan will probably operate in a desirable portion of its characteristic.

In order to make the use of the $Q/\sqrt{P}$ curves clearer, an example is given. Suppose that for some desired air volume the minimum calculated pressure gives a value of $Q/\sqrt{P}$ equal to 5 on the ordinate or vertical scale and that the maximum calculated pressure gives a value of 3. Assume also that the desired fan capacity is 60 on the relative capacity scale. The tabulation gives a comparison of the three types of fan illustrated by the curves.

Type of Fan	Relative Capacity ($Q/\sqrt{P}=5$)	R.p.m. Error, Per Cent ($Q/\sqrt{P}=5$)	Relative Capacity ($Q/\sqrt{P}=3$)	R.p.m. Error, Per Cent ($Q/\sqrt{P}=3$)	Speed Variation to Maintain Fixed Volume Between $Q/\sqrt{P}=5$ and $Q/\sqrt{P}=3$
Forward curve....	67.5	+12.5	43.8	—27	1.54
Radial tip.....	66.5	+10.8	47.5	—20.8	1.40
Backward curve...	69	+15	48.5	—19.2	1.42

With $Q/\sqrt{P}$ varying from 3 to 5 at constant volume, pressure varies 2.78 to 1. This, of course, is much beyond any reasonable limits for a carefully figured job.

Narrowing the limits of maximum and minimum pressure obviously reduces the necessary speed deviation. Radial tip and backward curve blading require less speed adjustment than forward curve blading in a majority of cases.

Reference to Figs. 1, 2, and 3 will reveal that fans have a very steep $Q/\sqrt{P}$ curve plotted with capacity Q as a base beyond 60 per cent of volume at free discharge. This means that errors in calculated $Q/\sqrt{P}$ for this outer portion of the fan characteristic will have relatively less effect on volume flowing.

It is apparent that a fan installed to meet maximum calculated pressure at or near the point of best efficiency may deliver an excess volume if not dampered back, should the actual pressure be less than calculated. The effect on horsepower must be considered when selecting the proper motor, particularly in the case of forward curve vane ventilating fans.

Another valuable feature of the graphical and calculated analysis is its likelihood of indicating unreasonable assumptions. For example, many ventilating estimates are based on expensive excess requirements. Power engineers frequently ask for absurdly liberal capacity at ratings probably never to be met. Mining engineers ask for volumes that no reasonable pressure nor horsepower would put through a mine to the working faces.

In conclusion, the author advocates extreme care in estimating fan requirements. Maximum and minimum pressure volume relations should be calculated; proposed fans should be studied from reliable characteristic curves; and quantity-pressure relations should be visualized on a simple curve sheet as explained.

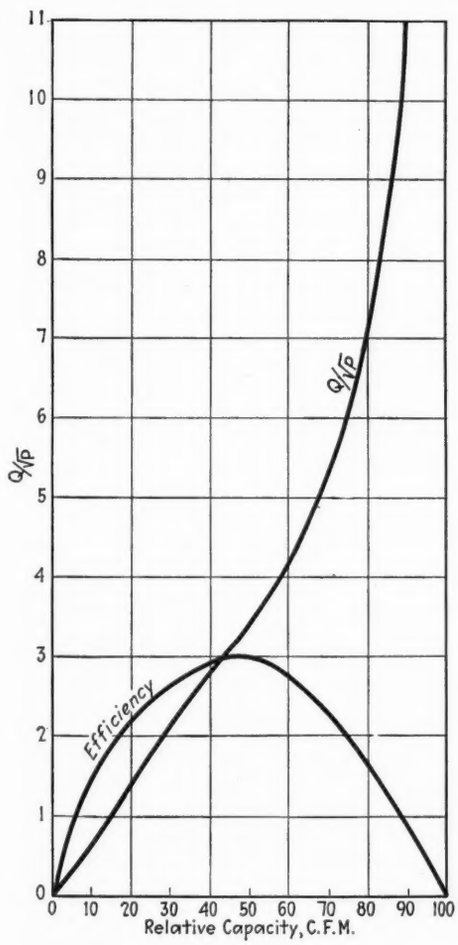


Fig. 1—Forward curved vanes

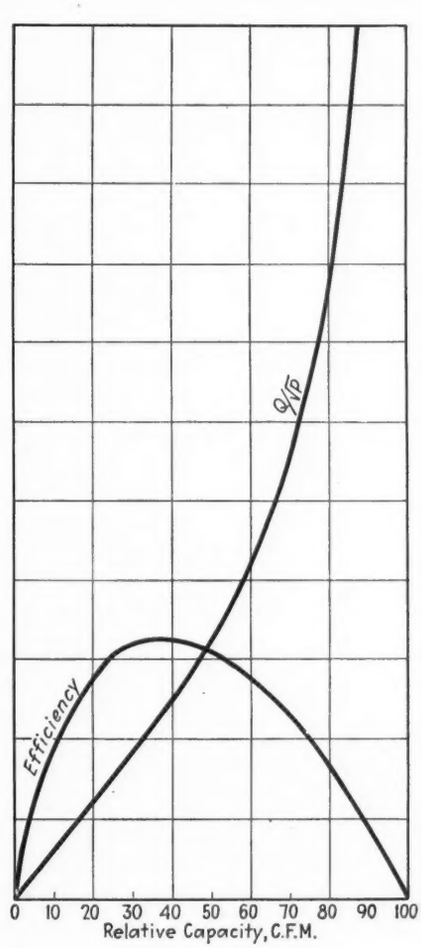


Fig. 2—Radial tip vanes

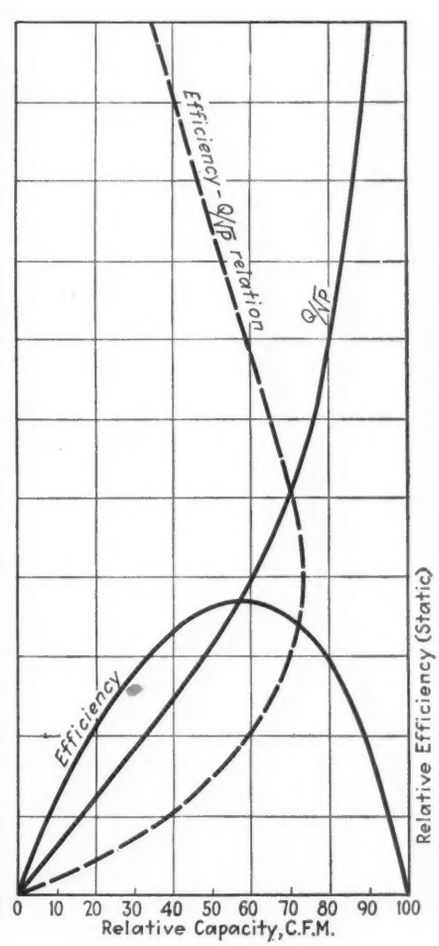


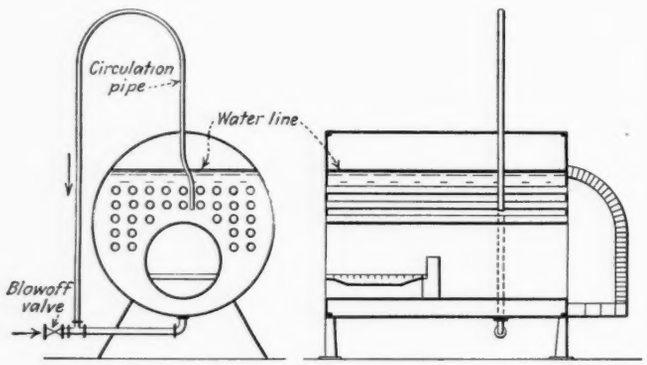
Fig. 3—Backward curved vanes

PRACTICAL AIDS TO OPERATION

Circulating Pipe Connection On Scotch-Type Boiler

THE INCLOSED sketch shows a circulating pipe connection that was recommended by a boiler manufacturer (he did not make Scotch boilers) as a cure for the cold bottom common to this type of boiler.

The circulation pipe is a bare 2-in. pipe connected to the boiler as shown, with the top connection extending well down below the water line and left open, while the outer end is carried about 6 ft. or more above the top



Recommended cure for the cold bottom common to Scotch-type boilers

of the boiler. Whether this would work as alleged and if so what action takes place might be interesting to those operating internally fired boilers.

I saw one boiler equipped as shown. While no readings were available to show the difference in temperature between the steam and the bottom of the boiler, which carried about 100 lb. gage pressure, to the hand no difference could be distinguished. Perhaps the scheme combines the principle of the Holly loop and the coffee percolator.

IRA A. BUTCHER.

Brooklyn, N. Y.

Diesel Engines Can Be Operated With One Piston Disconnected

IT IS not unusual for a marine type diesel to be operated with one of the pistons disconnected from the crankshaft. This is usually due to a badly scored cylinder liner, or possibly to breaking of the centrifugal ring oiler on a gravity-lubricated engine. The latter case was of a 500-hp., 6-cyl. engine on the S. S. *Bacoi*. The piston was disconnected shortly after leaving Singapore, Malay Peninsula, and the engine operated on the five remaining cylinders until the ship reached Hong Kong, China, 1,200 miles away, where the necessary repairs could be made. The engine, I might mention, operated almost as well on the five cylinders as it did on six.

It is, however, rather unusual for a diesel engine to be so operated when connected to an alternator that must be paralleled with other alternators. From all basic engineering facts it would seem that the engine would be so out of balance that parallel operation would be out of the question, particularly when the engine is a 4-cyl., 4-cycle engine.

In 1923, two 4-cyl., 400-hp. diesel engines were installed in the Port Au Prince, Haiti, plant of the Compagnie d'Eclairage Electrique, where I was then chief engineer. The load could easily be taken care of by one unit during the day, but at night, from 6 P.M. to 12 M, both engines were required. In starting one of the engines a defective starting valve caused the bending of a connecting-rod, a cracked cylinder liner and a broken piston. Having in mind the accident on the S.S. *Bacoi*, I decided to try to operate the engine on three cylinders until new parts could be procured from the factory, since no stand-by service was available.

The undamaged starting head (engines had but one starting cylinder) was moved to another cylinder, as was the starting cam. The accident occurred at 4 A. M., and the emergency repairs were completed at 2 P. M. The engine was started and paralleled with the running machine without difficulty. The results were surprising. The variation of voltage was so small that it could not even be noticed on the lights in the plants. (The generators did not have voltage regulators.) This engine was so operated for twelve days, six hours per day and carried up to 175 kw.-hr. without trouble.

I might also mention that so firmly does the management of this company believe in the reliability of their diesel engines that even today, when the capacity of the plant has grown to 2,350 hp., the peak load to 1,500 kw.-hr. and the yearly generated load above 5,000,000 kw.-hr., they still have no stand-by capacity, and neither are they interconnected with any other source of power. They do, however, employ a diesel engineer who is very capable and is second to none when it comes to emergency repairs and operation.

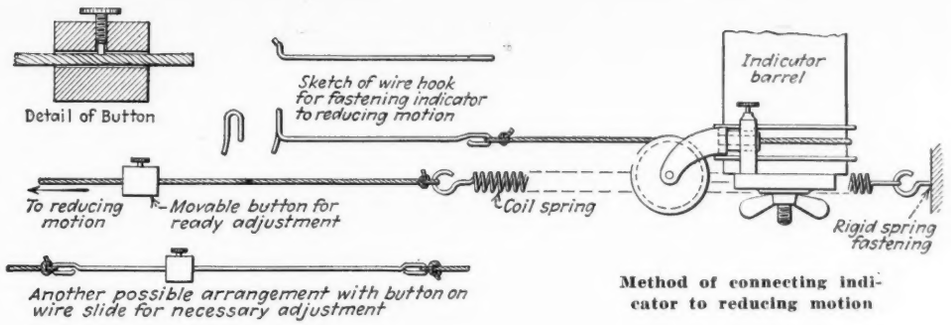
H. W. STALNAKER.

Osceola, Ia.

A Convenient Connection to Indicator Reducing Motion

DURING the past few months several articles have appeared in *Power* describing various methods of facilitating the taking of indicator diagrams. I would like to add a method I have found convenient for indicating compressors, steam engines, and internal-combustion engines in the oil-field and in the Mechanical Engineering Laboratory at the University of Oklahoma.

In this method the cord connection to the reducing motion is tied to a small coil spring or an elastic cable. The spring in turn is fastened to any rigid support available. On the cord is placed a small button made of some light material such as aluminum or hard-wood. This button has a setscrew with a small pin under it for clamping the button in any desired position on the cord. This position can be easily adjusted so that the reciprocating motion of the button is within the limits of motion of the cord to the indicator barrel. After the


Detail of Button
Sketch of wire hook for fastening indicator to reducing motion
Indicator barrel
To reducing motion
Movable button for ready adjustment
Coil spring
Rigid spring fastening
Another possible arrangement with button on wire slide for necessary adjustment

Method of connecting indicator to reducing motion

button has been adjusted for position, the indicator can readily be connected to the motion by drawing the indicator cord hook out to full length and releasing it ahead of the button. There is little danger of the indicator being jerked out of line or having an incomplete stroke since the limits of motion of the cord to the indicator barrel may be readily compared with the extreme position of the button before the hook is placed over the button.

One distinct advantage of this method is that the cord to the reducing motion is constantly under a higher tension than the ordinary indicator barrel spring would place on it. For this reason there is less tendency for sag or whip in the line. It is well adapted, for this reason, to higher speeds. A heavy button would be objectionable, but the weight can be kept down by making it of small size and of light material. A small brass pin under the setscrew will keep the screw from cutting the cord.

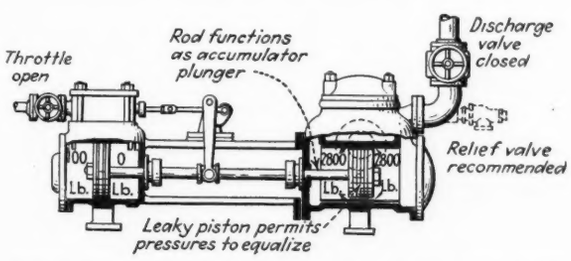
Sometimes it is desirable, especially with a semi-permanent hook-up for a medium- or slow-speed engine, to have the button on a section of wire in the line to the motion. Such an arrangement would eliminate any possibility for cutting of the cord and would make it unnecessary for a pin to be placed under the setscrew.

It is quite obvious with this method that the indicator need be in operation only while the diagrams are being taken, reducing indicator wear; and when a number of diagrams are to be taken, only one cord adjustment is necessary. These features, in addition to the advantages already mentioned, make the method a desirable one.

Norman, Okla. H. V. Beck, *Ass't. Prof.*
School of Mech. Engineering,
University of Oklahoma.

Relief Valve Protects Reciprocating Pump Against Excessive Pressures

The pump illustrated may be of the piston or inside plunger type and is assumed to be a low-presure tank pump having 6-in. water and steam pistons, operated at 100-lb. gage pressure and having $1\frac{1}{8}$-in. rod.



Relief valve between cylinder and discharge stop valve prevents excessive pressures being built in pump

When the discharge valve is open it is impossible to subject the water cylinders to more than 100 lb. gage. If the discharge valve is tightly closed, imprisoning the water, and the steam throttle is leaking or open and the water piston packing is leaking, the pressures upon opposite sides of the water pistons equalize. The $1\frac{1}{8}$-in. rod then functions as a single-acting accumulator plunger driven by a 6-in. steam piston. Under these conditions, neglecting friction, the pump may generate a pressure of $100 \times \left(\frac{6}{1\frac{1}{8}}\right)^2 = 2{,}844$ lb. per sq.in. if the pump is capable of withstanding such a stress. Usually it is not, and bolts or castings fail. Therefore, a relief valve, to be placed between pump and discharge stop valve, as indicated by the dotted lines is recommended for pumps of the piston or inside-plunger types, whether steam or power driven.

Belleville, N. J. G. F. Johnston.

Vibration of Compressor Records Operation on Thermometer Chart

Recently I came upon a practical "kink" which may be of interest to the readers of *Power*. The problem was to find through what part of the day our refrigerator compressor was operating. The machine is a 1-ton motor-driven ammonia compressor, connected to our cafeteria box.

We happened to have a 24-hour portable recording thermometer, which we supported so that it rested on the compressor motor. When the machine was in operation the vibration was just sufficient to cause the thermometer pen to vibrate, inking a line about $\frac{1}{16}$ in. wide. When the motor stopped, the pen inked its usual line, which is about $\frac{1}{64}$ in. wide.

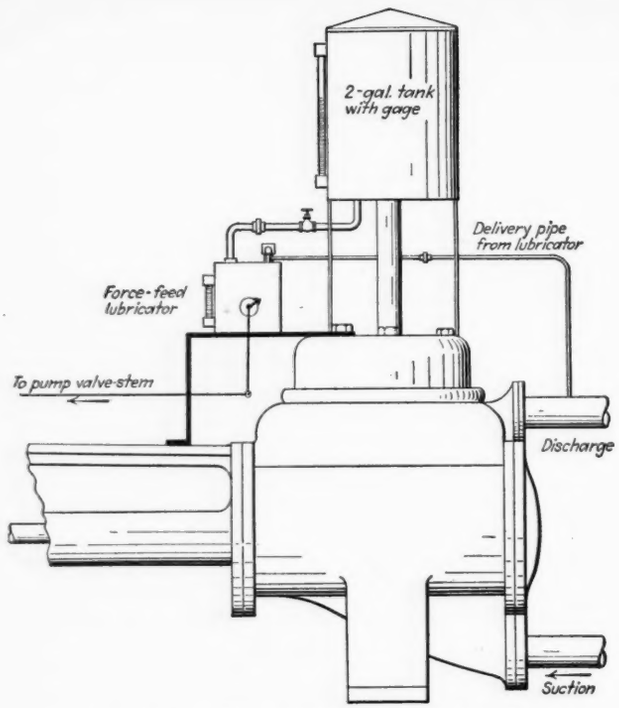
Several 24-hour charts were thus recorded, giving a definite record of the time during which the motor was running.

Rochester, N. Y. E. H. Lang,
Rochester Athenaeum and Mechanics Institute.

Force-Feed Lubricator Employed as Compound Feeder

Practically all boiler-compound manufacturers claim that for maximum results the feeding of the compound should be continuous and proportional to the amount of water evaporated. Many engineers have trouble with home-made feed devices and insist that the firemen use care in adjusting the feed valve, but usually a day's supply is fed in an hour or less.

The illustration shows a feeding arrangement devised by one engineer, which gives good results. As can be seen, compound is fed according to the speed of the



Lubricator gives continuous compound feed proportional to the water evaporated

boiler feed pump which is governed by the steam demand on the boiler. It is an easy matter to determine the amount of compound needed per gallon of water and to regulate the feed accordingly.

Arlington, Mass. E. MacDermod.

CURRENT COMMENT

Electrical Contact Sounds Horn When Pump Runs Dry

In our plant there are three centrifugal pumps supplying cooling water to our diesel engines, with a gage to show the water pressure. This gage has an electrical contact that may be set for different pressures. When one side of the twin strainer in the suction line plugs up the pumps, discharge pressure drops and the gage hand makes contact and causes a horn to be sounded to call the operator's attention. There is also on the same line a pressure-operated switch to energize a magnetic contactor that starts a pump for circulating water through the heating coils in the fuel-oil storage tanks. These switching arrangements could be used by O.F.R. to supply current to a relay connected to open the motor circuit and protect the pump from running dry.

Walthill, Neb. W. W. Dingwall.

Vacuum on Test Gage Shows Dry Pump

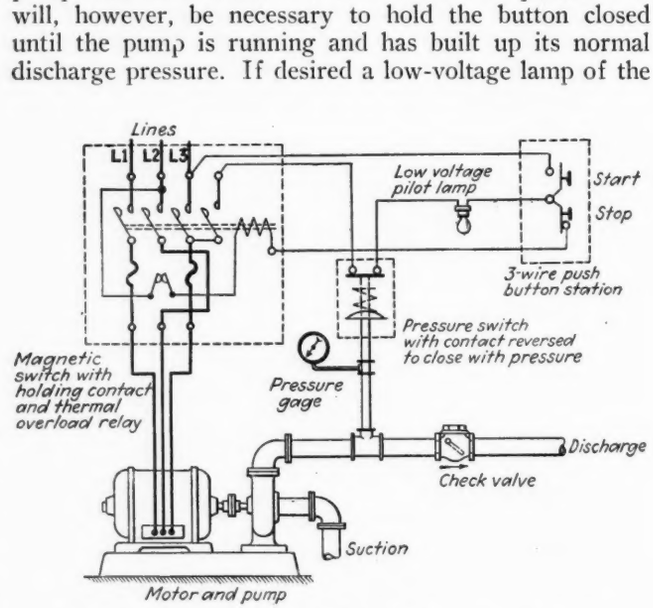
We used a centrifugal pump to unload tank cars. Occasionally a piece of waste material would lodge in the suction line, which would stop or materially retard the flow of liquid. When this happpened, the operator noticed a much higher vacuum on the test gage connected to the suction side of the pump. He then put a vacuum switch in series with the pump-motor starter's line switch coil and set it for 20 in. of vacuum. In case the suction became closed the vacuum switch would stop the pump, then the operator would clean out the suction strainer before restarting.

Los Angeles, Calif. P. L. Armstrong.

Protects Pump Against Operating When Dry

While O.F.R. does not state in his question, May 3 number, the type of motors and starters used on the pumps, it is assumed that the starters are standard magnetic switches with 3-wire push-button control. In this case, installing a pressure switch in the discharge line between each pump and check valve will be the simplest way of protecting them from running when dry. The contacts of the pressure switch are adjusted to close on pressure and remain closed when the pump is operating normally.

The pressure-switch contacts are connected in the holding coil circuit of the magnetic switch as in the diagram. When the contacts are arranged in this way the pump will start when the start button is pressed. It will, however, be necessary to hold the button closed until the pump is running and has built up its normal discharge pressure. If desired a low-voltage lamp of the



Installing a pressure switch in the discharge line between pump and check valve protects pump from running dry

proper current rating may be connected into the holding-coil circuit to show that the pump is operating. If the starter is of the manual type the pressure-switch contacts may be connected in series with the low-voltage release coil.

Altoona, Pa. A. R. Mankland.

READERS' PROBLEMS

STEAM CONSUMPTION OF ENGINE—*Can the steam consumption of a reciprocating engine be figured from the bore, stroke, cutoff and speed?* G.E.L.

Such computations have been a standard textbook problem for years, but they have only a limited application in practice because of the large and variable error caused chiefly by cylinder condensation.

In theory the solution is easy. Figure the cubic foot volume swept through by the piston from the beginning of the stroke to cutoff. Multiply this by the number of working strokes per hour. This supposedly gives the cubic feet of steam admitted per hour. Multiply this by the weight of one cubic foot of steam (see steam tables) at admission pressure to get the weight of steam consumed per hour.

Actually, there is always a considerable amount of condensation when the steam first enters the cylinder. While this is always less for compound and uniflow engines than for ordinary simple engines, it is substantial in all cases and will sometimes add 50 per cent or more to the theoretical steam consumption. If one is to guess at the amount of this condensation he might as well guess at the entire steam consumption, on the basis of experience with similar machines. Such typical experience is recorded in mechanical handbooks.

Practically, the engine is always in a plant or with the manufacturer. In the latter case guarantees are obtainable. In the former a test can generally be made by means of steam meters or by measuring condensate, or even by taking all steam from one or more boilers whose feed water is measured.

KEEPING BRASS PARTS SHINED—*I was much interested in the answer to a reader's problem in* Power *for May 24, regarding rustpoofing of an idle engine. I am wondering if you could advise me what preparation could be put on brass after it has been carefully shined that would make it impervious to finger marks and weather for perhaps a day or two.* J.H.

Tarnishing of polished brass is a result of oxidation in the presence of moisture. Consequently, any preparation which will prevent moisture from getting to the polished surface will prevent tarnishing temporarily. A light oil rubbed on and wiped off is usually used. The colorless preparation in the answer you read will serve. It may prove more satisfactory to lacquer or clear-varnish the surface immediately after polishing. This is a sure prevention against marking as a result of finger prints, but will eventually scale off and require refinishing. A beeswax and turpentine mixture will work fairly well, or a candle may be streaked across the surface and the lines rubbed down until they disappear. Or yet again, "Simonizing" will do the trick.

If you use lacquer, you may experience considerable trouble in removing it when it begins to scale. A rag wet in alcohol will do the job.

▼ ▼ ▼

Recommend Hand Firing

Stokers, pulverizers and oil burners find advocates among readers answering question of May 17

IN OUR PLANT we have two 78-in. by 20-ft. and one 84-in. by 20-ft. horizontal return-tubular boiler. These boilers are at present hand-fired, using a good grade of soft coal at $6 per ton. In the near future we contemplate changing to automatic stokers using a cheaper grade of coal, or we might change to oil fuel.

The boilers are set 60-in. from the floor and 40-in. above the grates. The steam demand is 21,000 lb. per hour with a fairly uniform load. It is desired to carry this load with two boilers.

We should like to get all the information we can before making these changes. Perhaps some readers of POWER *have had some experience in this line.* C. H.

Proper Setting Heights

IN RECENT months the Engineering Committee of the Midwest Stoker Association has worked on recommended setting heights for H.R.T. boilers equipped with mechanical stokers. These recommendations are shown below for the boilers in question:

Size Boiler	Distance from bottom of Shell to Floor
78 in. x 20 ft.	7 ft. 6 in.
84 in. x 20 ft.	8 ft. 6 in.

These setting heights may be used for developed loads up to 50 per cent above normal rating. Since C. H. wishes to carry a uniform steam load of 21,000 lb. per hour on two boilers, it is recommended that the above setting heights be increased 6 in. This is due to the fact that the boilers will be operating at somewhere between 175 and 190 per cent of rating if the load is fairly well distributed.

If fuel oil is burned, it is recommended that the heat release per cu.ft. per hour does not exceed 40,000 B.t.u. unless the refractory walls of the combustion chamber are cooled. With the boiler efficiency assumed, the hourly steam output, steam pressure, B.t.u. value of the oil known, the hourly fuel consumption can be determined. Then knowing the width and depth of the combustion chamber to be used, the height necessary in order not to exceed 40,000 B.t.u. per cu.ft. per hour can be determined.

New York City. R. S. JULSRUD.

Stokers Would Pay Cost in Seven Months

THE steam demand of 21,000 lb. per hour gives a rating of 93 per cent when all three boilers are being used. If one of the 2,050 sq.ft., smaller boilers were taken off the line and the other two boilers used they would operate at 134 per cent rating which could easily be carried by stokers, either of the underfeed or overfeed type.

If the large boiler were taken off the line and the two smaller boilers used they would operate at 149 per cent of rating. This likewise could easily be carried with stokers.

These boilers are somewhat low-set, and if stokers are installed they should be placed below the floor line to get sufficient furnace volume and insure smokeless combustion. Assuming that the large boiler required 49 sq.ft. of stoker grate area then it would require a distance of 5 ft. from the top of the tuyeres to the underside of the shell to secure 245 cu.ft. of furnace volume, which is sufficient to operate the boiler at 150 per cent of rating. Therefore, the stokers would have to be set in a pit about 27 in. deep.

Stokers for the three boilers in question would cost about $5,500 f.o.b. point of shipment, exclusive of erection, changes in brickwork, depression of floor line and electric wiring. The total outlay would be about $6,400.

The coal now used costs $6 per ton. Assuming that the evaporation is 8 lb. of water per pound of coal, the present fuel cost of steam will be around 37 cents per 1,000 lb.

With 14,000 B.t.u. coal a responsible stoker manufacturer will guarantee an efficiency on equivalent evaporation of about 10.5 at 150 per cent of normal rating. Assuming that a good grade of nut and slack coal can be purchased for $3.50 per ton, the cost of generating 1,000 lb. of steam with stokers would be 16.7 cents.

Operating 8 hours daily and 25 days per month, the saving would be $10,476 per year. It can easily be seen that the cost of the installation would be paid for out of coal savings in seven months.

The $6,400 invested in stokers which

would yield a return of $10,476 per year, is equivalent to a return of 163 per cent per annum.

In the light of a capitalized investment, $174,600 would have to be invested at 6 per cent interest to bring back the same return that $6,400 invested in stokers would yield.

WALTER H. SHURE.

Baltimore, Maryland.

Prefers Pulverized Coal

BY USING any two of the boilers at 150 per cent of rating the demand will be met, and without any undue loading of the boilers. Regarding automatic stokers, the modern trend in power plants is towards pulverized coal, even on boilers of considerably less horsepower where unit-type pulverizers are used. The advantages of this method of firing are many:

1. With proper combustion volume clinkers are eliminated.
2. Complete elimination of furnace grates.
3. Stokers are not capable of completely burning the lowest grades of coal; therefore the initial cost of the coal when it is to be pulverized is less than for a stoker.
4. Lower maintenance—the pulverized firing equipment is all outside the boiler.
5. Flexibility.
6. Saving of coal which is lost when banking with a stoker.

Altogether, the saving would be more with a properly designed pulverized coal installation than with a stoker.

Oil is an excellent fuel if it can be bought cheaply enough. Fuel should be bought on the cost of a million B.t.u.; therefore the price of oil is the deciding factor in the economical production of steam. If oil cannot be bought at a price to warrant its installation, I believe a unit-type pulverizer will give a more satisfactory and economical installation. J. W. BASORE.

Birmingham, Ala.

Oil and Stokers Neck and Neck

BOILER heating surfaces are not given in the problem May 17, but if the 78x20 boilers have 118 3½-in. tubes, they rate 2,370 sq.ft. each. The 84x20, having 142 3½-in. tubes, would rate 2,820 sq.ft.

Fuel oil, burned at the best efficiency to be expected, will show an equivalent evaporation rate of 14 to 1. Costing 3 cents per gal., weighing 8.22 lb. per gal., the fuel cost of evaporating 1,000 lb. of water from and at 212 deg. F. would be 26 cents. If the more conservative and representative rate of 13 to 1 was secured, then the fuel cost would be 28 cents per 1,000 lb. water evaporated.

Coal for stokers would cost $5.75 a net ton—25 cents a ton less than the cost for "a good grade of soft coal suitable for hand firing." This fuel, of 14,000 B.t.u., burned at 75 per cent combined efficiency, which is the best to be expected, would result in an equivalent evaporation rate of 10.8 to 1. The fuel cost per 1,000 lb. water evaporated would be 26.6 cents.

If the coal burning equipment were operated at an evaporation rate 10 to 1, the fuel cost would be 28.7 cents.

To convert the present furnaces to oil-fired furnaces is a problem best handled by a competent consulting engineer. Many boiler settings have been wrecked by being subjected to temperatures for which they were not designed.

To convert the furnaces for side dump underfeed stokers, reference should be made to the table of "setting heights" appearing in the general catalog of the Stoker Manufacturer's Association. To convert the furnaces for overfeed stokers of the front feed type, discussed in May 17 *Power*, on page 719, it will be necessary to drop the floor only 12 in. to secure the minimum setting height.

Proper oil-burning equipment or either type of stoker will develop 21,000 lb. steam per hour, provided the stack, breeching and flues are not restricted.

The controlling factor between oil and coal will be the fuel cost per 1,000 lb. steam, while the selection of the type of stoker will depend on local conditions and cost of installation. Either type is suitable. D. T. DOBYNS.

Montclair, N. J.

Fears Trouble from Boiler Forcing

THERE are several things which should be known before much can be said regarding the contemplated change, among them being the following;

The cost and heating value of the cheaper coal,

The heating value of the present coal,

The cost of fuel oil,

The savings to be realized by using two boilers in place of three,

Whether the present stack will have sufficient draft to carry the stokers at the required rating without the use of forced draft.

The heating surface of the boilers is not stated, but assuming that the two smaller boilers are about 1,750 sq.ft. each, that the larger one is about 2,100 sq.ft., and that the boilers would be rotated on the line, they would operate at about 175 per cent rating, which is rather high for H.R.T. boilers of the height these are set.

If they are forced at the proposed rate the flue gas temperature will probably be raised enough to offset a good part of the gain in furnace efficiency resulting from the use of stokers. If forced draft is necessary, the power required to drive the fan would have to be charged against the furnace. Forcing will probably also increase the cost of furnace maintenance.

If stokers are installed and operated with normal care the furnace efficiency may be raised 2 to 4 per cent or it may not, and unless the boiler feed water is very good the higher rating may cause trouble in the roundabout seam or burn the boiler, as low settings are prone to produce such results when forced.

This was forcibly demonstrated in a mining field where several H.R.T. boilers set 20 in. to 24 in. above the grates were practically all burned over or near the bridge wall while none of the boilers which were set 48 in. above the grates were burned, although they used the same water and operated under much higher steaming rates.

Brooklyn, N. Y. IRA A. BUTCHER.

Tips on Oil Installations

I AM going to deal with a change from hand-firing coal at $6 a ton to oil firing of Bunker "C" fuel oil at from 80 to 90 cents per barrel at the moment, delivered by boat.

The first thing to consider is the source of supply and possible available storage capacity, not forgetting to make due allowance for the peak demand (as a rule in February), for by chance the supply might be hampered or delayed by ice in creeks, in the case of boat supply, or snow in the case of rail delivery.

It's a simple matter to figure the necessary storage, knowing (1) the size of delivery boats (usually 7,000 barrels) or size and frequency of delivery of tank cars (10,000 gallons), and (2) consumption (figure 3½ bbl. per ton of coal).

This storage has to be heated in the winter, and a good temperature for pumping is 90 deg. F.

A set of reciprocating pumps (duplicate) is necessary to supply the pressure of oil at the burner. A pressure of 70 lb. is usually ample. The oil on leaving the pump should be heated; the heat in the pump exhaust can be utilized for this purpose.

A temperature just below the flash point of the oil should be maintained, about 150 deg. F.

The oil can be atomized by steam or compressed air. There are a number of burners on the market, but as a general rule the efficiency of an oil-burning system is not to any great extent dependent upon the burner but upon other factors surrounding combustion.

The present grates may be removed and the bridge wall thrown back to some extent and a new bottom to the furnace built at a lower elevation than the present grate in order to allow greater combustion space. The furnace bottom may be built on pipe let into the side walls.

Such savings can be made in the change over from hand-firing coal to oil that the total cost is amortized in a few years. It is scarcely necessary to go into the savings in detail, for any engineer knows his local conditions best. Savings are chiefly in, fuel cost, labor, ash handling, coal handling and storage and flexibility. G.H.H.

Bridgeport, Conn.

Refrigerating Engineers Discuss Vacuum Refrigeration

AMERICAN Society of Refrigerating Engineers held its Nineteenth Spring Meeting June 9-11, with headquarters at the Massachusetts Institute of Technology. A feature of the meeting was one technical session held on board the S. S. *Dorothy Bradford,* during its trip from Boston to Provincetown.

The first technical session was almost entirely devoted to the subject of vacuum refrigeration. While this method of refrigeration, using water as a refrigerant, is not new, nevertheless the advent of air conditioning, which requires relatively high temperatures from a refrigerating point of view, has created a new interest in this method.

The paper by D. K. Dean describes a multi-jet steam operated thermal compressor which produces a low absolute pressure in an evaporator containing water. The reduction of pressure above the water causes it to evaporate and absorb from the water the latent heat of vaporization. This reduces the temperature of the water to that corresponding to the boiling point at the existing pressure. The steam used in the thermal compressor, together with the water evaporated, is condensed in a surface or jet condenser, and the cooling water, if desirable, may be used for process purposes, since its temperature is raised appreciably by the steam it condenses.

By using brine or other liquid of lower freezing temperature, it is possible to obtain temperatures below the freezing temperature of water.

When cooling water to 45 deg. about 0.9 per cent of the water will be evaporated when its initial temperature is 55 deg. Under these conditions about 38,560 cu.ft. of vapor per minute per 100 tons of refrigeration must be handled by the thermal compressor.

In addition to its application for air conditioning purposes, work has been done on use of the thermal compressor for direct cooling of food products by introducing the product to be cooled into the evaporator or flash chamber. Laboratory experiments have been carried on with milk and tomato pulp as the food products to be cooled.

Discussion of the paper brought out that the equipment could be operated with low-pressure steam such as engine exhaust. With steam at 150-lb. pressure and 75-deg. initial water, about 26 lb. of steam per ton of refrigeration per hour would be required when cooling the water to 45 deg. The cooling water required would be 5.6 gal. per ton per hour.

The lowest temperature that is now commercially practicable was given as 20 to 30 deg. Compression ratios of 8 to 1 are feasible with this type of compressor.

A mercury ejector refrigerator was described by L. F. Whitney. In this machine mercury is boiled and its vapor is discharged through a nozzle, thus producing a vacuum above a water container. The water vapor from the evaporator condenses the mercury, which returns to the boiler while the super-heated water vapor is condensed in a suitable condenser and flows by gravity back to the evaporator. This equipment is suitable for small refrigerator units up to a capacity of 2 tons.

R. W. Waterfill described the use of steam ejector refrigeration for air conditioning of passenger railroad cars. Mr. Waterfill disclosed that less steam was required for air conditioning than would be demanded from the engine for winter heating of the railroad cars. About 35 lb. of steam per ton per hour is required and the units are built up to six tons capacity.

Direct Expansion Coils

The fourth paper of the first session covered the design of evaporator piping and was presented by H. C. Guild. Mr. Guild made a survey to determine why direct expansion coils were used infrequently. The survey disclosed that direct expansion was not used because of the fear of damage to equipment due to liquid slugs coming over into the compressor, difficulty of temperature control and damage to stored commodities in case of leakage in the direct expansion coils. He presented a diagram of an evaporator in which it was claimed heat transfer coefficients of 82 to 100 were possible without slugs of liquid going over to the compressor.

The second technical session was held on board the S. S. *Dorothy Bradford* during a trip from Boston to Provincetown. The first paper was presented by W. J. King, in which he reviewed heat transfer developments. Mr. King's paper contained an assembly of useful heat transfer data such as conductivity of materials, convection coefficients of air up to 300 deg. and of water flowing in pipes. A tabulation was given of the radiation emissivity coefficients of various materials.

In discussing evaporation, Mr. King pointed out the possibility of superheating of the liquid when the liquid under consideration was absolutely pure.

The second paper was by A. H. Berestneff. He discussed the effect of moisture content of materials upon their heat transfer coefficient. In this paper is presented data showing the amount of moisture absorbed by various building and insulating materials when in contact with air of various relative humidities. He also showed data indicating that in some cases the increase of conductivity was as much as 175 per cent with a moisture content of 25 per cent by volume.

Booster Compressor for Low Temperatures

At the Saturday morning technical session, held at the Massachusetts Institute of Technology, four papers were presented. The first was a description of a rotary compressor by Harry Sloan. This rotary compressor, it was pointed out, was particularly applicable for use as a booster with a single-stage compressor for the purpose of obtaining extremely low temperatures now necessary in the quick-freezing of various food products. The rotary compressor consists of a shaft on which two eccentrics are formed. These eccentrics carry on them a cylindrical rotor mounted on ball bearings. In effect the rotor rolls on the surface of a casing in which is arranged a vane between the inlet and discharge part. It is claimed that the compressor when operating at a 10 in. vacuum suction and discharging against the 25 lb. pressure, has a volumetric efficiency of about 90 per cent.

A review of lubrication technique was presented by B. L. Newkirk in which he discussed the theory of film lubrication, oiliness and the use of water and water grease for lubrication purposes.

In the paper "Control of Solid CO_2 Refrigeration," J. G. Bergdoll and A. W. Russ presented various methods which they had tried for the control of this method of refrigeration. The method finally adopted consists of an endless tube arranged in two interconnected coils, one substantially above the other, so that a volatile liquid hermetically sealed inside the tube will drain by gravity from the higher coil into the lower coil. The solid carbon dioxide in an insulated chamber is placed in contact with the condenser, and the chilling action condenses the gas evolved from the volatile liquid in the evaporator. As the evaporation takes place, heat is absorbed by the evaporator from the space to be refrigerated. An adjustable thermostatic valve is placed in the gas line between the evaporator and the condenser, and controls the refrigerating effect of the evaporator.

The last paper of the session, by J. L. Gibson, describes a direct expansion calorimeter for measuring capacities of small refrigerating machines. This paper was read by E. R. Ryan, chairman of the Boston committee which arranged the details of the meeting. The main feature of this calorimeter was the use of a secondary refrigerant which was maintained at room temperature, the heat necessary to do this being supplied by electric resistance coils. The electrical input to the heating coils is a measure of the refrigerating effect produced by the machine.

A.S.M.E. Oil & Gas Power Division Meets at Penn State

THE fifth National Meeting of the Oil and Gas Power Division of the A.S.M.E. was held at Pennsylvania State College from June 8 to 11. Over two hundred engineers attended to hear the presentation of papers.

Following the registration, a brief engineering session was held on Wednesday morning. The first paper at this session, by Edward A. Richardson, was entitled "Heating Fuels for Injection Engines."

The author outlined the several plans proposed by various investigators to preheat fuel oil before introduction into the engine cylinder. If the oil is raised above its critical temperature and pressure, a gas and not a liquid will enter the engine. This will reduce the lag between fuel introduction and ignition, thereby enabling a heavy oil to be burned in high-speed engines.

In discussing the paper, J. Groff mentioned that experiments with critical heating of oil had been made by Bethlehem Steel Company with considerable success. He felt that the plan offered reasonable expectations of commercial application. A contrary view was held by J. Kuttner, Oberhaensli & Cie., who could see no merit in the preheating system. Dr. Dickerson could see no basic objection to the proposed plan merely because it was old. He doubted, however, the advisability of heating the oil by pump work.

Jerk-Pump Fuel Injection

In his paper, "Spray Characteristics of a Jerk-Pump Fuel-Injection System," O. F. Zahn, Penn State College, presented the results of a test on a Bosch fuel pump. It was found that the variables which could be changed are speed, load and nozzle-opening pressure. These affect combustion only as far as they change temperature, turbulence and spray characteristics.

Prof. Everett, Penn State College, expressed the opinion that the paper included data heretofore unavailable. Edgar J. Kates hoped that other pumps would be tested in like fashion.

The first paper of the Wednesday afternoon session was "Surface-Volume Ratio as a Critical Factor in Automotive Diesle Combustion Chambers," by Julius Kuttner. The author held that the ratio of surface to volume in a high-speed diesel was so much less favorable than the ratio in a slow-speed engine, that operation was uncertain without some means of heating the air charge. Especially does this apply to L-head engines, and for such engines a division of the combustion cavity is imperative.

In a written communication, Prof. Neuman of Germany described tests he had run on an Oberhaensli engine. This engine has a heating bowl in the combustion chamber, and it was found that the design gave ample ignition temperature and sufficient air turbulence. On the other hand, E. T. Vincent, Continental Motor Co., doubted that the ratio was of any interest, for as speed increases heat losses decrease.

Fuel-Spray Formation

The second paper of the session was "Fuel-Spray Formation," by Dana W. Lee, Langley Field, Va. He described tests in which the sizes of drops were determined by catching them on lampblack surfaces. The diameters ranged from 0.00075 to 0.007 in., with the majority 0.002 in. in diameter. The speaker stated that he had found that the density of the air had little effect on drop diameter.

In the discussion, Col. O. E. Allen suggested that the air be raised to 450 lb. pressure, as he felt that 200 lb. failed to simulate operating conditions. Dr. Schweitzer, Penn State, stated that he is doing some work on the same subject but along different lines.

In the third paper, "Combustion Knock in Diesel Engines," by Dr. P. H. Schweitzer, Penn State College, it was revealed that all the factors that cause a gasoline engine to knock tend to eliminate knock in a diesel. To substantiate this claim the author listed the various elements influencing gas-engine behavior, and showed that the opposite effect would exist in a diesel. One point brought out that the carbon-hydrogen ratio is highly indicative of an oil's knocking proclivities; this shows that the old idea that light oils tended to burn without knocking was well grounded.

E. Nibbs, Electric Boat Co., expressed the belief that the Pearsonian Correlation Factor could be employed in choosing a fuel. He believed that open nozzles were better than closed nozzles when burning heavy oils.

Ignition lag, so C. W. Baierlein, United Bosch Corp., believed, is affected by the shape of the combustion chamber more than by any other single point.

Improved 2-Cycle Efficiency Crosshead

At the Thursday morning session, E. G. Beardsley and J. M. MacKendrick, Clark Bros., presented a paper entitled, "Fuel Injection in Gas Engines," dealing with the improved efficiency of two-cycle gas engines when the gas was injected after the exhaust ports were closed. The thermal efficiency increased from 16.8 to 25.8 per cent, exceeding the four-cycle efficiency of 25.5 per cent.

The second paper, "Metallurgical Problems of Diesel Engines," by Russell J. Allen, Worthington Pump and Machinery Corp., consisted of a summary of the metals now available for engine construction. Especial emphasis was placed on the new alloys.

On Friday morning, the session first considered the report of the A.S.M.E. Diesel Power Cost Committee. Due to a delay at the printers, the report was received too late to be digested. Copies of this report may be obtained from the American Society of Mechanical Engineers.

The Committee's secretary stated that in the next report cylinder-liner wear would not be tabulated, due to the difficulty of obtaining accurate data.

Col. O. E. Allen questioned the desirability of omitting plant numbers from the charts, as was done this year. In this he had the support of Edgar J. Kates and L. R. Ford. In regard to liner wear, the suggestion was made that a new sub-committee be formed to cover this report. This met with approval of several, and the executive committee promised to consider the subject.

Efficiency and Over-All Economy

The later part of the session was devoted to a paper, "Improving Operation and Over-all Economy of Diesel Stations," by H. W. Stalnaker. The author claimed that too many diesel plants were using expensive fuels when cheap boiler oils can be burned successfully. He cited one plant reported in the A.S.M.E. report where a distillate oil is being used, even though the engines were of a type suitable for Bunker C oil.

Louis R. Ford claimed that unless motorships use Bunker C oil, they cannot compete with modern steamers. G. Christy, Standard Oil Co. of New York, claimed that the author did not understand the refiner's position. Bunker C oil was not a drug on the market and in his opinion few diesels can handle the heavy fuel. To prove this he quoted from a discussion that appeared in *Power* some months ago.

Inertia Supercharging

The last technical session, on Saturday morning, was devoted to the presentation of a paper, "Inertia Supercharging of Engine Cylinders," by E. S. Dennison, Westinghouse Elec. & Mfg. Co. The author gave a mathematical analysis of the action induced by the inertia effect of the intake pipe. This analysis enables the engine designer to compute the correct pipe diameter and length, and to anticipate the cylinder's volumetric efficiency.

The technical sessions were separated by various social activities. On Wednesday night a card game occupied attention. On Thursday afternoon a picnic was held in the mountains. On Friday afternoon a golf tournament claimed the attention of many, while others visited the exhibits of engine accessories and the All Spray Laboratory. These activities were followed by a banquet in the evening.

Grease for Lubrication of Hydraulic Turbine Submerged Parts*

LUBRICANTS for hydraulic turbines must function successfully in contact with water, and at times in temperatures near the freezing point of water. The grease must be of such a nature that it can be forced through pipes and drilled holes in guide vane spindles without leaving a deposit or residue that will tend to clog the passageway. For turbine lubrication, any grease containing a filler should be avoided. Such greases consist of lubricating oil thickened by the addition of asbestos, mica, talcum, resin, chalk, etc. When these greases are used for turbine lubrication, the filler tends to form a deposit in the grease passages and clog them. Often these deposits are so hard that it is necessary to drill them out. Further, this type of grease is likely to disintegrate in the presence of water, consequently it has small lubricating value in submerged locations.

Grease is quite commonly manufactured by the lime soap method. Some ten to twenty per cent of fatty oil is mixed with lime water and heated. This results in the production of soap. Mineral oil is combined with this soap to form a grease of the desired consistency. Lime soap greases must contain a certain amount of water. If this water is lost through evaporation, the grease separates into its constituents. Such greases disintegrate when submerged.

A satisfactory grease for turbine lubrication must be highly impervious to water, free from solids, and of suitable consistency at operating temperatures. Satisfactory greases are on the market, produced by the blending of a fixed oil of animal or vegetable origin with a suitable mineral oil.

Method of Application

In applying the grease it has been found that the pressure gun and Alemite fitting to the individual bearings gives the best results. Where a central pressure system is used, it is necessary to open the connection to any one bearing at a time and to watch the movement of the pressure ram in order to determine if the bearing has taken grease. If there are two or more outlets for the grease, it will usually take the easiest path, to the exclusion of the others.

Similarly, if there are several points around the bearing where the grease may discharge, it will flow out on the slack side and escape from the bearing. It has been found more satisfactory to have a single discharge hole located on the pressure side of the bearing, with a suitable groove cut for distributing the grease along the spindle.

If the lubrication system of a turbine is carefully laid out and a proper lubricant used, the gate rigging bearings should go for fifteen or twenty years without developing excessive slack. Most satisfactory results will be obtained if one man is responsible for the lubrication of all the turbines in a power house. Such a person should be properly instructed and supplied with suitable equipment.

The normal annual turbine lubrication cost in one power house, containing eight 15,000-kw. vertical units, amounts to $145 per unit for labor and material. The cost of overhauling the gate rigging on one of these units, renewing bronze bushings, turning down spindles, etc., would be approximately $3,000. In addition, the unit would be shut down for at least three weeks. It is apparent that the additional cost of first class maintenance is fully justified by the resulting saving on repairs.

Greasing Schedule

It is well to have a definite greasing schedule on all mechanical equipment. This must be determined largely by experience. The following is a typical illustration of greasing instructions which are issued to each power-house superintendent by one Canadian company:

"The following greasing schedule is suggested, but need not be adhered to in every detail if the station superintendent feels that a less frequent schedule is sufficient to prevent rusting and undue wear:

"Top and bottom turbine guide-vane stems, twice a week; guide-vane thrust bearings, operating ring, links, levels, push and pull rod, once a week. Whenever the turbine is unwatered for a general inspection, it is advisable for one man to stay in the casing while another greases the upper and lower guide vane bearings. The man in the turbine is to note when grease begins to squeeze out around the stems. In this way about the proper amount of grease can be determined.

"Sluice gate and head-gate hoists should be well greased about once a month, whether used or not, to prevent rusting. Hoist cables should also be kept well coated with a heavy rust-preventing grease. The power-house crane should be thoroughly greased once every three months.

"Water-circulating pumps, sump pumps, and fire pumps should be greased twice a week when being used, less frequently when standing idle.

"The operator should bear in mind that sufficient greasing is one of the most important factors in safe and satisfactory operation of any piece of high-class mechanical equipment, also that a small amount of grease applied at proper intervals, is much better than excessive greasing at long or irregular intervals. He should also make it a point to keep the equipment under his care clean, and any repairs or replacements should be made without delay. Daily log sheets should show the dates the various items are greased, so that the operating superintendent and the system operator will know that greasing is carried out according to schedule."

*Report of the subcommittee on lubrication of submerged parts of hydraulic turbines, presented at the 42d annual convention of the Canadian Electric Association, at Manor Richelieu Hotel, Murray Bay, Que., June 15 to 17, 1932.

▽

Another Plan to Utilize Solar Energy

THE sun's heat as a source of power has always interested certain scientific and engineering minds. The French, in particular, have given much thought to the matter. The most outstanding attempts along this line are the recent well known experiments of Claude in Cuba where, at great expense, a large pipe line was laid to draw cold water from the depths of the sea, this to be used as a condensing medium for vapors (from the upper warmer sea layers) proposed through a turbine.

Another interesting plan for generating power from solar heat was recently proposed by Monsieur H. Barjot, in a communication presented before the Academy of Sciences in Paris, and published (in Franch) in Vol. 194, No. 17, of the Proceedings of that Society.

In this paper Monsieur Barjot dismisses as impracticable all schemes for utilizing the sun's heat which use mirrors or lenses. Like Claude, he would make the use of differences in temperature between surface water and lower water, and would pass the vapor from the warmer water through a turbine to a condenser cooled by the colder water. Unlike Claude, he proposes to augment this temperature difference artificially by selecting a controllable area of water and covering it with a layer of oil. This, he says, will enormously increase the temperature rise of the upper layer due to exposure to the sun.

He also suggests that the plan be applied to bodies of water located in sunny tropical regions and estimates that he might easily obtain there a temperature difference of 54 deg. F.

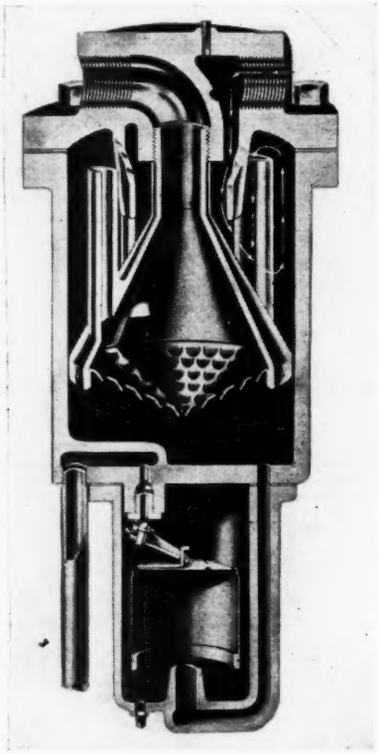
Monsieur Barjot computes that, with this temperature difference, from a sheet of water 15 meters (about 50 ft.) square he could obtain about 200 kw.-hr. per day.

Readers of *Power* will recall that in the March 2, 1930, number was published a description of Barjot's even more sensational plan for generating power from the "heat" of ice-bound polar seas. These seas, while very cold (around 32 deg. F.) are at a much higher temperature than the surrounding air. The resulting temperature difference Monsieur Barjot proposed to use for operation of a plant using highly volatile hydro-carbons as a medium for the operation of the turbine.

WHAT'S NEW IN PLANT EQUIPMENT

Combination Air Separator and Trap

THIS combination air separator and trap, put out by the Direct Separator Company, Inc., Syracuse, N. Y., incorporates the standard separator unit made for some years by the company. Air with entrained moisture enters the

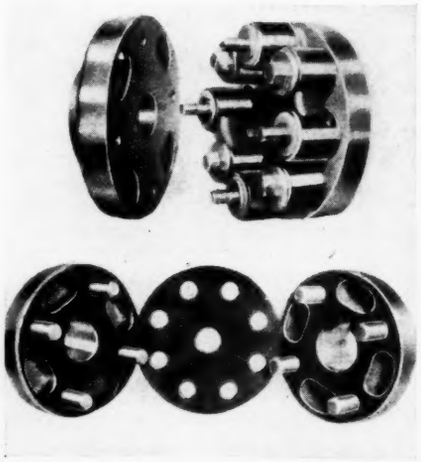


separator as indicated by the arrows. The velocity of the air downward throws the water to the top surface of the cone and it drains over the edge to the water chamber. The flow of air is changed upward to and into the top of three tubes leading to the inner side of the cone, where the direction of flow is again changed upward to pass into the outlet.

Water and oil removed from the air passes downward through a cored passage in the body of the trap and enter at the center of the inverted bucket. The combined unit is made in sizes from ½ to 2 inches.

Flexible Couplings

AN IMPROVED type of flexible coupling claimed to overcome faults previously associated with drives of this kind is

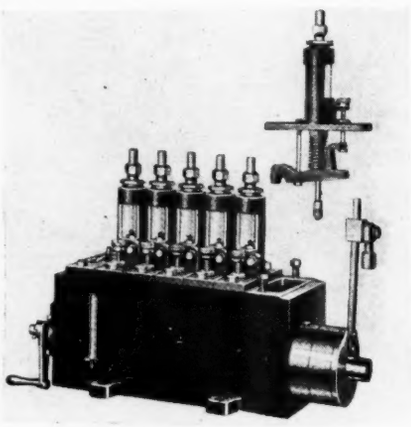


announced by F. A. B. Manufacturing Co., 67th and Vallejo Sts., Oakland, Calif. The new coupling, in addition to compensating for parallel and angular misalignment or combinations, embodies a shock-resisting feature and method of eliminating vibration. The manufacturers state that no lubrication is required and claim that the improved coupling will operate noiselessly at 3,450 r.p.m. It is being manufactured in sizes up to 1,200 hp. Complete information and a new bulletin may be procured from the manufacturers.

Force-Feed Lubrication

IN THE force-feed lubricator announced recently by S. F. Bowser & Company, Inc., Fort Wayne, Ind., a single plunger serves the dual purpose of drawing the oil from the reservoir and forcing it in a straight vertical path through the sight glass to the point of lubrication at the end of the feed line. Each pumping unit is individually adjusted and removable while the lubricator is in operation.

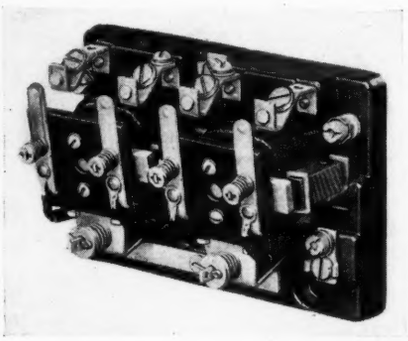
A simple method of refilling the sight glasses has been incorporated. A standard lubrication fitting permits injection of the liquid by means of a grease gun. The new lubricator can be furnished with any number of feeds and with any type of driving mechanism required.



Bowser force-feed lubricator

A. C. Reversing Contactor

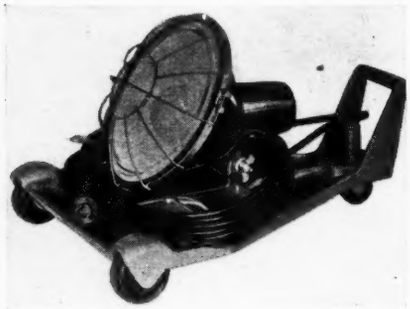
AN A. C. reversing contactor Class 8711, Type K, of small dimensions and particularly adapted to small hoist, window and door control, and similar uses, is being manufactured by the Square D Co., Industrial Controller Division,

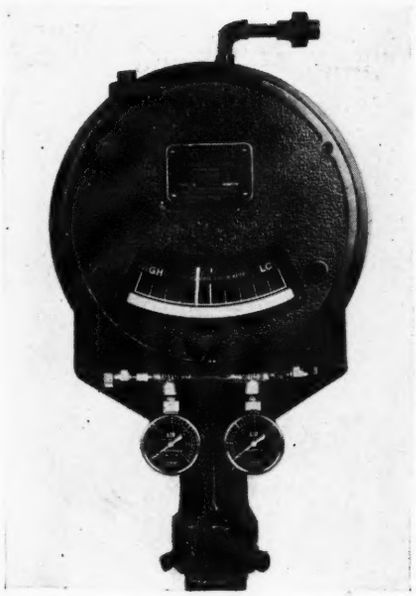


Milwaukee, Wis. Contactors are mounted on a porcelain base, are mechanically interlocked, and have silver-to-silver contacts. The maximum rating is ¾ hp., single or 3-phase. The dimensions are 6 in. wide x 4 in. high x 3¼ in. deep.

Weatherproof Portable Floodlight

THE "Mobilite," a weatherproof enameled floodlight mounted on a free-rolling, three-wheeled truck is being introduced by Benjamin Electric Manufacturing Co., Des Plaines, Ill. The Mobilite is claimed to make possible better illumination in limited spaces where other suitable illumination is not provided. It is made of porcelain enamel steel on a cast truck with fiber rollers.



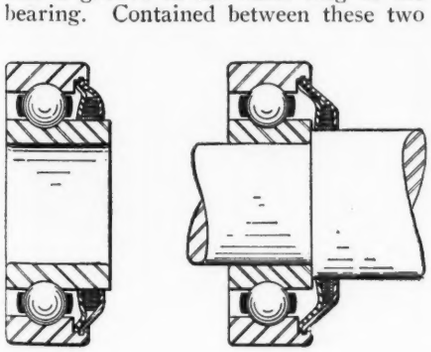


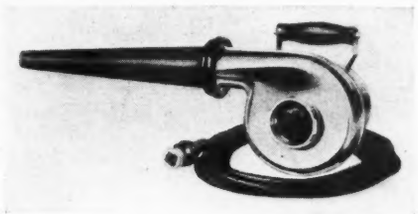
Liquid Level Indicator

THE liquid level "Stabilog," an instrument designed especially for the continuous process industries, is being introduced by the Foxboro Co., Foxboro, Mass. This Stabilog is said to prevent surges in flow. It is made in two types, throttling and averaging. The first is used in processes where it is desirable to hold a close level and yet have a smooth throttling valve action that will not set up surges in the controlled flow, and the second allows the level to vary within safe limits but holds the outflow as nearly uniform as possible. The Stabilog is a combination of the Foxboro Stabilog control system and the Foxboro differential pressure-type liquid level gage. Bulletin No. 181 describes the unit.

Improved Ball Bearings With Oil Seal

AN IMPROVEMENT in oil retention construction for ball bearings was recently patented by George O. Hodge of Plainville, Conn. and assigned to Standard Steel and Bearings, Inc., Plainville, Conn. The patent number is 1,839,677. The oil retainer, or seal, is composed of two circular plates wedged together into a groove in the outer ring of the bearing. Contained between these two circular plates is a wiper or ring of felt that makes contact with the inner ring of the bearing as at left, or with a shaft as at right. The felt wiper or ring forms an oil-stop or dam that retains the lubricant within the bearing. Plate construction and assembly are such that there is a constant pressure against the felt ring between the plate-members, this pressure being intended to press the felt ring constantly against the rotating inner ring or shaft so as to improve the sealing contact to take up wiper wear as it develops.





Portable Electric Blower

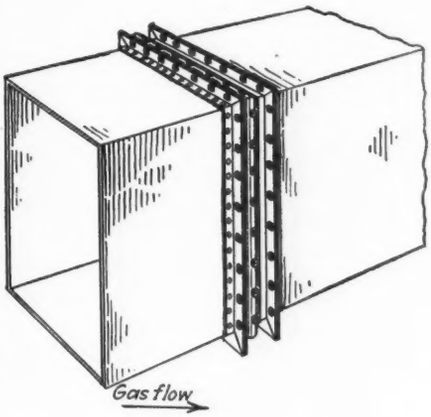
A PORTABLE electric blower, the Tornado Model 4 for blowing dust out of motors and machinery parts, vacuum cleaning bins and stock rooms, has been announced by the Breuer Electric Mfg. Co., 852 Blackhawk St., Chicago, Ill. The blower is almost identical in design and construction to the large heavy-duty line of Tornado blowers.

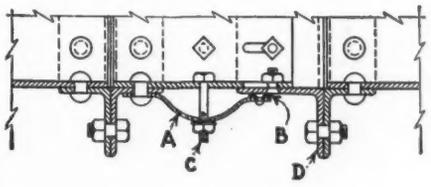
Automatic Oiling System

AN AUTOMATIC oiling system, operating electrically without pump or other moving parts, has been developed by Motor and Plane Accessories, Inc., Detroit, Mich. It consists of an oil tank, made by the Westinghouse Electric & Manufacturing Co., equipped with a heater unit separated from direct contact with the oil. When the machine to be lubricated is started, the electric heater unit within the tank is automatically turned on. Raising of the oil temperature causes expansion and forces oil out of the tank to the bearings where proper metering devices control oil flow. After the temperature has reached 150 deg. a thermostat breaks contact and allows the oil to cool to 100 deg. At that temperature the cycle is repeated. During the cooling process a vacuum occurs which is utilized to refill the tank from a central supply or reservoir. To prevent drawing the oil back from the bearings, a check valve is used in the main feed line, and an auxiliary feeder holds the pressure on the main line while the tank is refilling.

Expansion Joint for Flues and Ducts

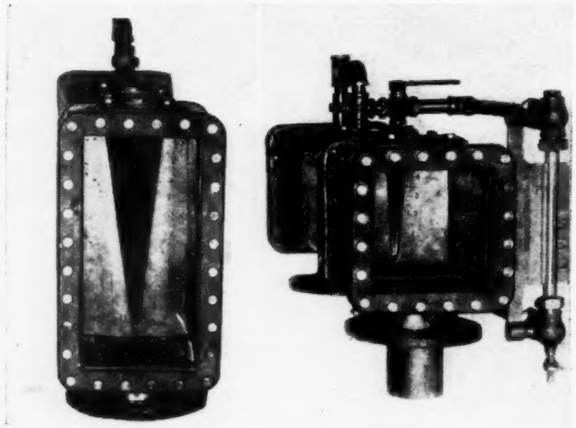
AN EXPANSION joint for flues and ducts which allows expansion and contraction of the flue without rupture or distortion of the metal of the joint is being manufactured by Bergen Point Iron Works, Bayonne, N. J. It is made up complete in the shop and bolted or riveted to the flue in the field. It is applicable to rectangular, irregular or round flue sections. Expansion is taken care of by an asbestos lining *b*, riveted to a spring clip *a* which is held down by bolts *c*, sliding on an angle *d* with which asbestos lining *b* is always in contact. There is no distortion in the spring clip, for expansion is allowed by movement of lining *b* on angle *d*.

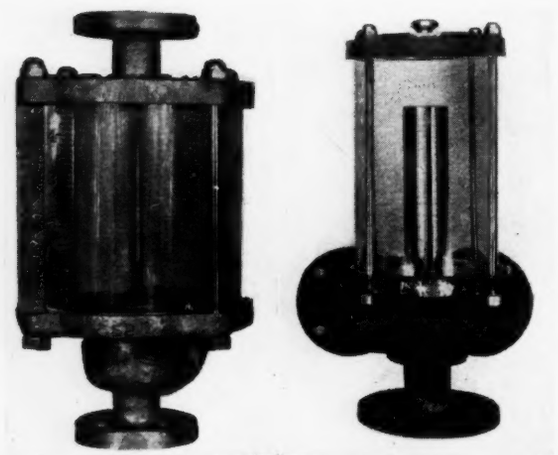




Two Types of Weir and Orifice Meters

A LINE of V-notch weirs and orifice meters in two body sizes is being furnished by The Vulcan Copper & Supply Co., 120-126 Sycamore Street, Cincin-





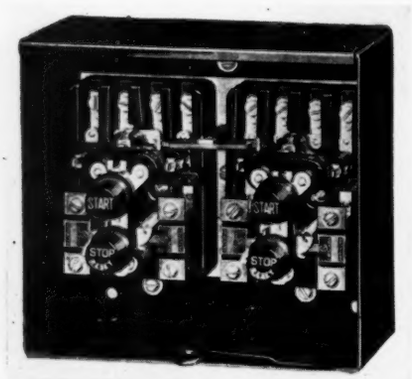
face before flowing through the weir. In front of the weir plate is a section with glass plate and discharge pipe. An external gage glass with scale facilitates reading of the liquid level. Meters are furnished regularly in copper, bronze or aluminum and are also available in gray iron, monel metal, nickel, chrome nickel steels and other corrosion resistant materials. Each weir is individually calibrated at from twenty to thirty points and the calibration chart is supplied with the meter. Slot and orifice meters built inside of glass cylinders are also offered, in two standard body sizes. Both take interchangeable measuring weir or orifice tubes in orifice plates so that either body size is supplied with several tubes and plates to allow necessary range in use and capacity. The slot weir shown in the first figure has a graduated vertical tube in which one or more slots are accurately machined. The base casting admits liquid in an annular ring around the tube to eliminate turbulence. For the accurate measurement of smaller amounts of liquids, an orifice hole is drilled near the bottom of the vertical tube instead of milling the weir slot. When a horizontal orifice is desired, this is supplied in a plate which may be secured in the same hole as the tube.

nati, Ohio. The smaller size body takes plates having maximum capacities of 200, 300, 500, 1,000, 1,500 and 2,000 gal. per hr., while the larger size has standard plates with maximum capacities of 2,000, 3,000, 4,000, and 5,000 gal. per hr. Plates are readily interchangeable.

The body consists of a long box or calming section designed to allow the liquid to present a mirror smooth sur-

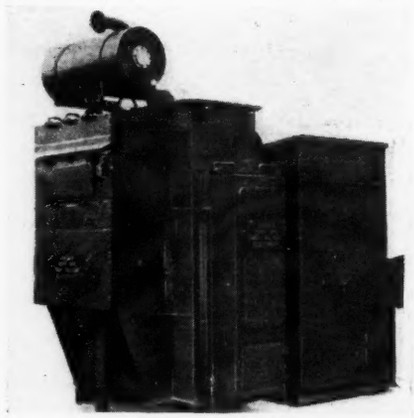
A. C. Manual Starters, Reversing and Two-Speed

TWO-SPEED separate-winding type and single-speed reversing-type starters for controlling across-the-line motors have been added to the line of A. C. manual starters manufactured by the Industrial Controller Division, Square D Co., Milwaukee, Wis. Both types are claimed to have general application, but the two-speed type is considered especially suitable for heating and ventilating purposes and similar installations where remote control is not essential. Maximum horsepower ratings of the three-pole starters are 5 hp. at 220 volts and 7½ hp. at 440-550 volts. Features are claimed to be: front operation, thermal overload protection, operation of any relay opens main line completely disconnecting motor from line, two quick break switch mechanisms interlocked to prevent simultaneous operation, and pushbutton reset without replacement of any parts after an overload. Maximum dimensions are: 13⅜ in. wide, 10⅞ in. high and 5½ in. deep.



Packaged Substation Units

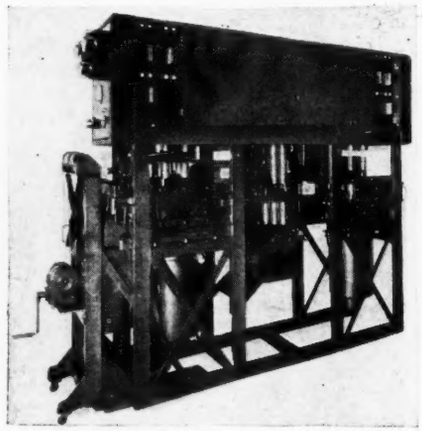
TRANSFORMER and switch gear designed as a unit and assembled at the factory are incorporated in the substation units



announced by the General Electric Co., Schenectady, N. Y. The design permits additional feeders to be provided at a minimum of expense, makes an exceptionally good appearance because of the absence of overhead structure, and allows the total installed cost to be estimated easily and accurately for budgeting. Equipment includes a three-phase transformer, with a high-voltage oil-immersed disconnecting switch, an enclosed high-voltage fuse compartment, an automatic equipment for changing the ratio of the high-voltage winding under load, and the necessary switchgear. Included are a panel with voltmeter, ammeter and watthour meter, current and potential transformer, oil circuit breaker, relays, disconnects, fuses, etc. The equipment is metal enclosed and takes approximately 12 by 10 ft. Each additional feeder position adds approximately 2½ ft. to the 12-ft.

Metal Clad Switching Unit

A METAL-CLAD switching unit with main and transfer bus to control 4,100-volt three-phase feeder circuits equipped with three single-phase regulators, has been developed by the Delta Star Electric Co., 2,400 Fulton St., Chicago, Ill. Interlocks make it possible to energize only the feeders one way and convenient means are provided for putting the regulators in or out of service, to insure ready inspection or adjustment. By means of a portable truck, shown at the left, the main and regulator breakers can be removed quickly or placed in service.



Improved Inverted Bucket Steam Traps

Two patented improvements have been incorporated in the line of inverted bucket steam traps made by the Strong, Carlisle & Hammond Co., Cleveland,

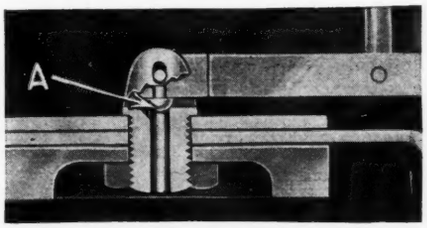


Fig. 1—Anti-balancing device

Ohio. The anti-balancing device illustrated in Fig. 1 at *A* is used on all sizes of inverted bucket traps with the exception of the Nos. 70 and 81, which will be described in a forthcoming issue. The device consists of a valve arrangement in the lever which replaces the conventional air vent in the bucket. This valve is arranged with a small opening to allow the air and other gases to escape from the bucket while the trap is filling.

The semi-steel inverted bucket trap fitted with the anti-balancing device is shown at top in Fig. 2, while the forged steel trap fitted with the device is shown below. Both types are furnished with internal Monel metal strainers, stainless buckets, Anum-Metal seats, disks and operating mechanism. They are built for pressures up to 1,800 lb.

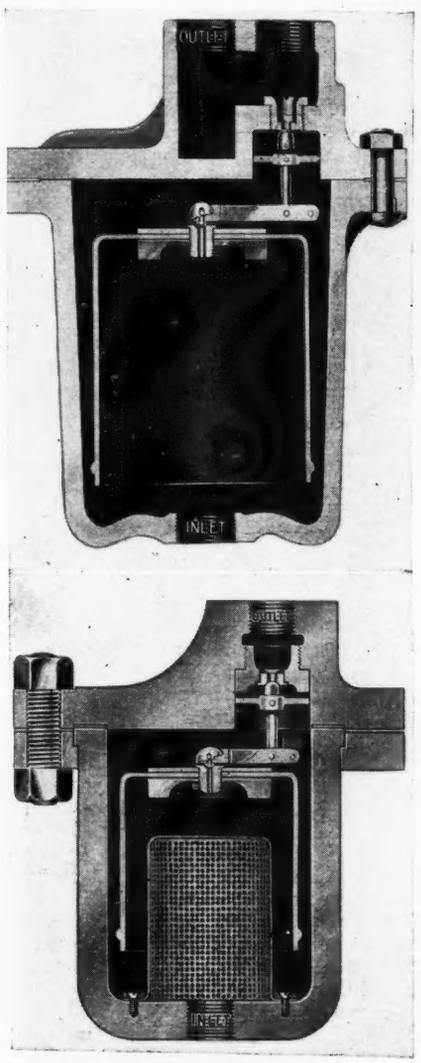
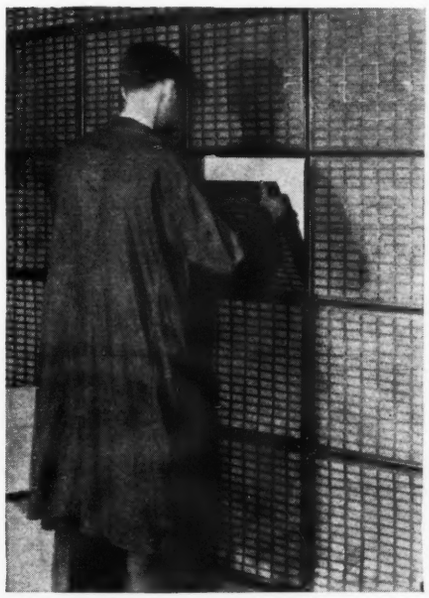


Fig. 2—Two types of Strong inverted-bucket steam traps fitted with the anti-balancing device, the semi-steel above and the forged-steel below

Glass Wool Air Filter

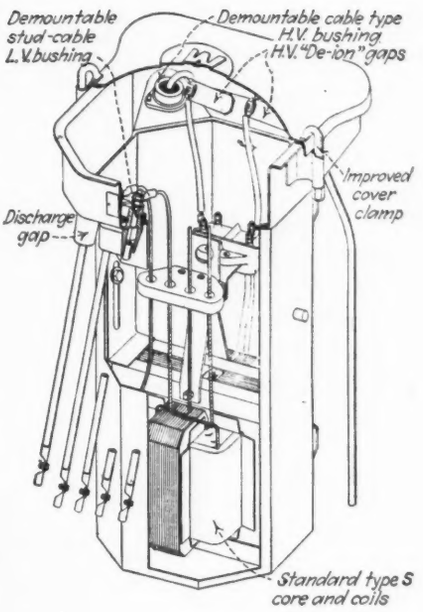
An air filter of glass wool which the manufacturers think will revolutionize the art of air conditioning is announced by Owens-Illinois Glass Co., Toledo,



Ohio. It can be produced at low cost and possesses a high efficiency, besides practically eliminating the factor of servicing. The new product will bear the trade name of "Dustop" and is replaced entirely when dirty. The container is of paper, establishes a tight seal between the filter and the metal frame into which it fits, and the unit itself is 2 in. thick, and weighs 2 lb. It may be used as a standard 4-in. pack by using two units in tandem or two units placed face to face, only one unit being changed at a time.

Surge-Proof Distribution Transformer

This distribution transformer which is not injured by lightning surges entering either the primary or secondary windings, is being announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The protection of this transformer is independent of external connections or ground resistance. "De-Ion" surge protective gaps are placed inside the transformer tank and so connected to the windings as to limit



the voltage stress that can exist between the high voltage and low voltage winding, and between these windings and the core and case. With this protection no voltage stress higher than a predetermined safe value can exist upon any part of the transformer insulation. Fuse outages due to lightning surges are eliminated. The transformer is claimed to be universally applicable to any type of distribution system, to any system of transformer connections, either single-phase or three-phase, and for any grounding practice desired. It is described in detail on folder 8248-A.

Equalizing Non-Reflux Elbow

The equalizing non-reflux elbow illustrated is for use in forced and gravity hot-water heating systems and has been perfected by Erwin L. Weber, consulting engineer of Seattle. The Crane Co., Chicago, is distributor. The elbow is designed to overcome incorrectly balanced flow of water to each unit of radiation. The object of the Weber elbow is to eliminate the various objectionable features of the usual elbows, in addition to saving the necessity of draining and refilling the system during radiator repair. In Fig. 1 the valve is shown full open, in Fig. 2 automatically closed after the water attempts to enter a broken or disconnected radiator, and in Fig. 3 in partly closed position for equalization of flow. This adjustment can be carried to a full closed position, when it acts as a shut-off valve. The unit is claimed to assist hot water heating in high buildings.

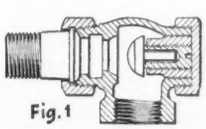


Fig. 1

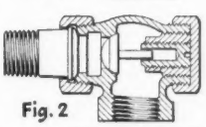


Fig. 2

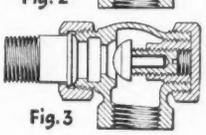


Fig. 3

NEWS of the WEEK

Steam Plant Bids Asked for Capitol

MARKING another step in the work of linking together Federal projects already completed, those under construction or being planned, the Treasury Department has called for bids for the construction of the steam distribution system to be connected with the Central Heating Plant. Proposals are to be filed with the office of the supervising architect of the Treasury before June 23, when they will be opened for this project, which will provide one heating system ultimately for 26 Federal structures.

The central heating plant is to be erected just to the south of the extensible building of the Department of Agriculture, on a site located between Twelfth, Thirteenth, C and D Streets.

Plans for the plant have been drawn, the cost being estimated at $5,749,000.

Another step in this project has been taken with the awarding of a contract for the purchase of the huge boiler for the heating plant, which has been given to the Combustion Engineering Corp., New York. The bid was for $426,647, with an option, running the duration of the term of this contract, for the purchase of two additional boilers, if found needed, for approximately $106,000 each.

The purchase contract for the boiler was let at this time, so that final measurements on the size of the boiler might be determined and employed in final plans for the heating plant structure.

The steam-distribution system for which bids now are sought will involve construction of about a mile and a half of new tunnels and about a mile length of new steam conduits. In this project the Government plans to make use of about a mile-and-a-half length of steam-distribution tunnels now existing.

New York State Section of N.A.P.E. Elects Officers

F. L. Bigbie of New York City was elected president of the New York State Association of the National Association of Power Engineers at its 37th annual convention in Binghamton, N. Y., June 10 and 11. T. J. Hogen of Buffalo was elected vice-president; Bartley McCourt of Buffalo, secretary; B. W. Howell of Buffalo, treasurer; Linn Seeley of Endicott, conductor; C. A. Clark of Binghamton, doorkeeper; W. P. Poynton of New York City, chaplain; and P. F. Cassidy of New York and W. J. O'Brien of Syracuse, state deputies. The election was the closing event of the two-day meeting.

Engineering School Authorized at Yale

The Yale Corporation has authorized the existing Division of Engineering to assume the status of a school with the title of the Yale School of Engineering. The school will include the functions and activities in civil engineering, including drawing, chemical, electrical and mechanical engineering, metallurgy and engineering mechanics. Under the new arrangement all engineering students will be under the jurisdiction of an engineering faculty, and engineering degrees will be conferred upon its recommendation.

Ten Million Volts Produced by 50,000,000-kw. Generator

Ten million volts of eelctricity, twice as great as any voltage previously produced by man in electrical laboratory experiments, was produced June 11 in the high-voltage engineering laboratory of the General Electric Co. at Pittsfield, Mass. This voltage, capable of producing a 60-ft. arc, was made possible by a new 50,000,000-kw. generator, according to F. W. Peek, Jr., chief engineer. Voltages of this order will probably be used in testing transformers and other equipment subject to damage by lightning flashes, which average about 100,000,000 volts.

So. California Edison Compromises With Los Angeles Users

A co-operative arrangement between the Southern California Edison Co., Ltd., and the Los Angeles (Calif.) Bureau of Power & Light, whereby the company offers certain electrical energy, steam plant stand-by service and rate reductions in return for delay in construction of the bureau's proposed steam generating station at Wilmington, was proposed recently by the company to the city's board of water and power commissioners. The commission instructed E. F. Scattergood, chief electrical engineer of the bureau, and a member of the city's legal staff, to frame a reply.

The Edison company's offer was made by Fred B. Lewis, vice-president and general manager. In his communication to the commission, he proposed, as an alternative to construction of the city's proposed steam plant,, that the city and the company join in a ten-year contract whereby the company continues to sell the power bureau the energy it requires above its own production, a six per cent reduction in rates effective Jan. 1, 1933.

COMING MEETINGS

American Society of Mechanical Engineers—Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. C. W. Rice, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers—Hotel Pfister, Milwaukee, Wis., June 27-29. A. V. Hutchinson, 51 Madison Ave., New York.

Minnesota Power Show — Annual State convention, Minnesota State section N.A.P.E., and power show, Curtis Hotel, Minneapolis, June 22-24.

Universal Craftsmen Council of Engineers. Annual convention at Cedar Point, Ohio, Aug. 8-13. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

Kearny Station Adds 75,000-kw. Unit

A 75,000-KW. turbine generator was put into preliminary operation June 15 by Public Service Electric & Gas Co. at its Kearny generating station. The new unit will increase the capacity of Kearny Station from 214,500 to 289,500 kw. The turbine generator, with its auxiliary equipment, is housed in an extension, recently completed, to the existing turbine room at Kearny. Because of recent advancement made in turbine generator design the new unit will occupy no more space than other generating units there which have considerably less capacity.

To provide for the additional steam needed to operate the new turbine, improvements have been made to twelve of the Kearny station boilers during the past twelve months. The firebrick walls of each boiler have been partially replaced, and the rear walls wholly replaced by water tube walls. In this way the boilers have been made to operate at higher capacities and thus generate the additional quantities of steam needed for operation of the 75,000-kw. machine. When operating under full load the turbine will require 780,000 lb. of steam per hour.

Another feature of the new equipment installed at Kearny is the huge welded steel condenser used with the new turbine generator. Weighing more than 16½ tons and containing 11,900 brass tubes, each 24 ft. long, the condenser is the largest of its kind ever built.

Energy Production Drops 12 Per Cent in April

Kilowatt-hours of electrical energy generated by central stations during the month of April were 6,254,207,000, a decline of 12 per cent from the same month of last year. Of this total, 3,394,212,000 kw. were generated by fuel, a decline from last year of 20.2 per cent, and 2,859,995,000 were generated by hydro plants, an increase of 0.2 per cent, according to the N.E.L.A.

Wholesale commercial sales of light and power accounted for 2,616,410,000 kw. of the total, though commercial and industrial demand is off 21.3 per cent from the same month of last year.

The per cent of energy generated by waterpower, 31.6 per cent last year, increased to 35.3 per cent this year. Average pounds of coal per kw.-hr. declined from 1.56 to 1.50 in the year.

As of April 30, the value of all central station plant and equipment was $13,000,000,000, up $600,000,000 from the same date last year. Steam generating capacity increased about 500,000 kw. to 24,016,000 kw., while waterpower generating capacity increased 896,000 to 8,999,000 kw. Internal combustion generating capacity increased 6,000 kw. to 448,000 kw., to make a grand total of 33,463,000 kw. The number of large light and power commercial consumers increased from 534,971 to 574,549 during the year.

Who Owns Water Power Of the St. Lawrence?

A number of questions involving the province of Ontario have yet to be settled in connection with the St. Lawrence waterway, and until these are disposed of it will be impossible for Canada to conclude a treaty with the United States, Premier Bennett announced on the last day of the recent session of Parliament. Discussions with Ontario, he said, had proceeded satisfactorily but there were still one or two outstanding matters to be settled. He did not know the exact time when the questions would be settled; it might be ten days or two months.

In answer to a question as to whether an agreement had been reached as to the ownership of water powers in the international section of the St. Lawrence River, the prime minister replied that until this matter had been dealt with by the highest court, no decision on the point could be made. For the purposes of the agreement between Ontario and the Dominion, however, the water powers in the international section were regarded as being the property of Ontario.

The High Priest invokes the Shinto god's blessing prior to breaking ground for the erection of the new Japanese plant of the Otis Elevator Company. This plant will be located between Tokyo and Yokohama and when completed will manufacture equipment necessary for the installation of elevators

Canada Reports On Central Station Output

Canadian Government reports that the output of central electric stations in the Dominion during 1931 amounted to 16,610,000,000 kw.-hr., including an estimate of 218,000,000 kw.-hr., for small stations which do not report monthly. The large stations, generating more than 98 per cent of the total of all stations, reported a total output of 16,391,510,000 kw.-hr.; 16,078,653,000 by water power and 312,857,000 generated by thermal engines. The Government reports increased electrification of many industries, while the lighting load, both commercial and domestic, has grown rapidly.

During the year the export of electricity to the United States amounted to 1,235,325,000 kw.-hr. or 7.4 per cent of the total output. Of this, 170,783,000 kw.-hr. was surplus power exported by the Ontario Hydro Electric Power Commission and Canadian Niagara Power Company from the Niagara plants which was a decrease from the surplus exported in 1930 of 231,536,000 kw.-hr.

PERSONALS

LEON P. ALFORD, mechanical engineer of Montclair, N. J., now vice-president of Ronald Press Co., New York City, and ALFRED D. FLINN, director of the Engineering Foundation, New York City, will receive honorary degrees of doctors of engineering from Worcester Polytechnic Institute at this year's graduation exercises June 17.

G. M. EATON, director of research of Spang, Chalfant & Company, Pittsburgh, and D. B. BULLARD, vice-president of the Bullard Company, Bridgeport, have been appointed to the Standing Committee on Research of the American Society of Mechanical Engineers.

COL. PHILANDER BETTS has received the honorary degree of doctor of engineering from George Washington University. He is chief engineer of the Public Utilities Commission of New Jersey.

JOHN DOUGLAS FITCH has been appointed an engineering assistant of the American Engineering Council and will join the staff Aug. 1. He will take over a portion of the work handled by Mr. Van Leer, formerly assistant secretary, who will take up the position of Dean of Engineering at the University of Florida on September 1.

ANSON MARSTON, dean of engineering at Iowa State College, will retire from his administrative duties on June 30. He will be succeeded by T. R. AGG, now assistant dean. Dean Marston has been a member of the faculty at Iowa State for 40 years and has been dean of engineering for 28 years. He will continue in charge of certain courses, but will devote much of his time to research work.

GEORGE L. MOREHEAD, vice-president of Link Belt Co., Chicago, Ill., has been elected a director.

A. L. NELSON, who for twelve years has been a member of the firm of Jackson & Moreland, Boston, as well as manager of its construction department handling problems relating to plant investigation, operation, and construction, now has established a business of his own under the firm name of Arthur L. Nelson Engineers, for the same type of work as before.

H. S. WOODRUFF has been appointed engineer in charge of the design section of the newly formed air-conditioning department of General Electric Co., according to an announcement by Pres. Gerard Swope. Mr. Woodruff came to General Electric in 1913 in the railway control design department, resigned during the War to engage in special work, and re-entered General Electric in 1926.

CALEB MILLS SAVILLE, manager and chief engineer of the water bureau of the Metropolitan District Commission, Hartford, Conn., has been awarded the president's premium of £10 by the Institution of Water Engineers, of England, for his paper "Modern Dam Construction," presented before the summer meeting of the Institution at Harrogate, England, last May.

HERBERT M. SHARP, chief engineer of the C. R. Huntley Station, Buffalo General Electric Co., has been elected vice-president of the Engineering Society of Buffalo for the year 1932-1933.

BUSINESS NOTES

ENGLISH & LAUER, INC., 1224 South San Pedro St., Los Angeles, Calif., has been appointed Southern California representative of American Air Filter Company, to handle the company's complete line of air filtering and dust control equipment.

PUMPS & SERVICE, INC., has been established in Seattle, Wash., with headquarters at 1232 First Ave. South, to sell, install and service pumps and water system equipment. Crawford Reid, R. J. Gosman and Walter Bailey, former employees of Pump Equipment Co., are members of the firm which will distribute Westinghouse water systems, centrifugal and industrial pumping equipment manufactured by Allis-Chalmers, and deep well plunger pumps and similar equipment.

E. A. MCCALLUM, representing Roots-Connersville-Wilbraham, Connersville, Ind., blower, pump and meter manufacturer, has moved from Los Angeles to San Francisco to Room 620, Hearst Bldg. Other recent changes in addresses of Roots-Connersville-Wilbraham representatives are: B. T. Ehrnman is now at 3300 Morganford Road, St. Louis; and C. B. Coldwell has relocated the Texas office at 307 Southland Life Insurance Bldg., Dallas.

How's Business?

Security markets have been steadied and financial anxieties soothed by forecasts of cessation of the gold outflow, despite the fundamental fact that the increased value of the dollar abroad and at home puts additional handicaps on our export trade and further pressure on commodity prices, both now relapsed to pre-war levels. Structural steel requirements have risen under stimulation of public construction, but steel activity and coal output have dropped to dismal depths. Merchandise carloadings also have declined with the sharp recession of retail trade under pressure of curtailed consumer purchasing power and employment. Improvement in electric power production (1,435,471,000 kw. for the week ending June 11, according to the N.E.L.A.) and check payments, however, have helped sustain the surprisingly stationary position of our general business index during the past three months. Uncertainty regarding relief legislation and congressional adjournment, as well as the outcome of European conferences and the domestic political campaign, still overshadows the summer outlook, but the prospect for further procrastination in comprehensive, cooperative action on all important issues is as favorable as ever for those who feel that they can safely be left to the laissez-fairies.—*The Business Week*, June 22.

New Bulletins

STEEL PIPE—American Society for Testing Materials, Committee A-1 on Steel, has issued a preprint of the report which was presented at the thirty-fifth annual meeting, June 20-24. Included in the preprint are proposed tentative specifications on electric fusion welding, electric resistance welders, forge welders, lock-bar and riveted steel and wrought-iron pipes.

LIGHT METALS AND ALLOYS—American Society for Testing Materials, Committee B-7 on Light Metals and Alloys, Cast and Wrought, has submitted three proposed tentative specifications in its 1932 report to be presented at the annual meeting, June 20-24, to cover aluminum alloy rods, magnesium-base alloy sheets, and magnesium-base alloy wrought shapes.

TEST OF DAM MODELS—University of Iowa, Iowa City, Iowa—Bulletin 2, New Series No. 230, dated July 1, "Laboratory Tests on Hydraulic Models of the Hastings Dam," by Martin E. Nelson, assistant engineer, U. S. Engineer Dept., under direction of Col. Wildurr Willing, district engineer, Corp. of Engineers, U. S. Army.

SUMP PUMP—Taber Pump Co., Buffalo, N. Y.—Bulletin describing its standard sump pumps for drainage, sewage and blow-off basin.

TRANSFORMERS—Wagner Electric Corporation, 6396 Plymouth Ave., St. Louis, Mo. —Bulletin 172 describes its transformers. This bulletin is in loose-leaf form to permit keeping it up to the minute.

STOKER—Johnston & Jennings Co., Cleveland, Ohio—Bulletin No. 7 one of a series of bulletins on developments in stoker design. Title of No. 7 is "How Would You Write the Specifications for a Good Stoker Fire?"

WIRE & CABLE—General Cable Corp., 420 Lexington Ave., New York, N. Y., will market the products of its component divisions under one name and symbol, "General Cable." The changeover is described in the company's newest bulletin describing its building wires and cables.

TUBE CLEANERS—Liberty Mfg. Co., Jeannette, Pa.—Bulletin Z-9 describes OS cleaners for small tubes such as in surface condensers, heat exchangers, ammonia condensers, closed heaters, etc., and Bulletin Z-10 describes cleaners built particularly for cleaning still tubes in oil refineries.

VENTILATING FANS—L. J. Wing Mfg. Co., 154 West 14th St., New York, N. Y. —Bulletin No. F-5 describes Wing-Scruplex Safety Ventilating Fans.

AUTOMATIC SEPARATORS—Leavitt Machine Co., Orange, Mass.—Catalog A describes the Swendeman automatic separator that removes oil and water from compressed air lines. The catalog includes a list of dealers and necessary specifications.

New Plant Construction

Compiled by the McGraw-Hill Business News Department, Which Is Prepared to Furnish a More Complete Daily Service to Those Who Wish It

Calif., San Francisco—Public Utilities Comn., opened bids June 6 for construction of Sections A, B and C of Coast Range Tunnels, 28.6 mi. long in connection with Hetch Hetchy water project, Cont. No. 135 City Utility Department San Francisco is lowest bidder. $5,257,665.

Colo., Colorado Springs — City, Light and Power Dept., awarded contract for turbine to General Electric Co., Schenectady, N. Y., $93,800; boiler to Springfield Boiler Company, 1901 East Capitol Ave., Springefild, Ill., $50,500. This corrects report published in May 24 Issue.

Ill., Belleville—Bill introduced in House of Representatives at Washington, D. C., for Army Air Field including construction of operations building, gas plant, heating plant, loading field improvements, etc. Estimated cost is $785,000.

Ill., Blue Island—City postponed indefinitely proposed municipal light and power plant. $40,-000. A. L. Fox is city engineer.

Ill., Chicago—Treasury Department, office of J. A. Wetmore, Acting Supervising Architect, Washington, D. C., awarded contract for construction and alteration to 4 story, basement, marine hospital addition, including boiler house, laundry, garage buildings, X-ray department, to A. W. S. Construction Co., 520 North Michigan Ave. Estimated cost $500,000.

Ill., Joliet—State, Springfield, having plans prepared for the remodeling of power plant at old state prison, including 2 new 400 h.p. boilers, stokers; breaching, piping and general alterations. Estimated cost $65,000. C. H. Hammond, 160 West La Salle St., Chicago, is architect and L. A. Snider Engineering Co., 605 West Michigan Ave., Chicago, are engineers. Maturity late in summer.

Ind., Anderson—Guide Lamp Corp., plans construction of 2 story, 50 x 200 ft. brick plant addition, incl. addition to boiler room. Owner builds and will purchase two 225 hp. boilers.

Ind., Crown Point—City voted at special election June 7, to establish municipal light and power plant to provide current to operate waterworks, lighting city streets and buildings.

Ind., Harmony — School Commissioners Clay County, completed plans for construction of a new heating plant, including heating and plumbing equipment, septic and pressure tanks, steam boiler, etc. Estimated cost is $25,000. C. W. Allen, Swope Bank Bldg., Terre Haute, is engineer.

Ind., Muncie—Bell Teachers College awarded general contract for remodeling boiler plant to Pickett & Gill Inc., 420 Continental Bank, Indianapolis; piping to Hayes Bros., 236 West Vt. St., Indianapolis; stoker to American Engineering Co., Aramingo and Cumberland Sts., Phila., Pa., boilers to Henry Vogt Co., 1100 Orvil St., Louisville, Ky. Estimated cost is $40,000.

Mass., East Braintree—Braintree Electric Light Co., East Braintree, will take bids until June 21, for construction of a 2 story, 60 x 90 ft., power house addition, and alterations to present power house, including changes of equipment. R. H. Marston, 70 Kilmarnock St., Boston, is architect.

Mo., Kansas City — Dri-Ice Refrigeration & Service Co., c/o R. S. McGuire, 1533 Grand Ave., Kansas City, has taken option on site and plans construction of a dri-ice plant at 19th St. and Kansas Ave. Estimated cost is $150,000.

Mo., St. Louis—Bd. Public Service, City Hall, will take bids in July for 1st unit Negro Hospital, including laundry and power plant at Goode, Kennerly, Ferdinand and Whittier Sts. Estimated cost $300,000. A. Osburg, is city engineer. L. R. Bowen, city architect.

New York—Northern New York Utilities Co., 59 Public Sq., Watertown, plans electric power plants and distribution system in Lyonsdale, Lewis Co. and Brownsville, Jefferson Co. Company applied to Public Service Commission for permits.

N. Y., Diana—Harrisville Electric Light & Power Co., Harrisonville, plans electric plant and distribution system, here and parts of Lewis Co. $40,000. Application made for permit.

N. Y., New York—New York Steam Corp., 280 Madison Ave., plans altering 2 story, steam generating plant, including inter-connecting 7 steel stacks by horizontal ducts with necessary supports at 222 Pearl St. Estimated cost $40,-000. W. H. Paine, 417 East 35th St., is engineer and architect.

New York, N. Y.—Board of Transportation, J. H. Delaney, chn., awarded contract for furnishing and installing electric light and power system for Concourse shops and yard of Independent System of City-owned Rapid Transit Railroads to Dierks Heating Co. 208 East 31st St., $73,987.

N. Y., Ogdensburg—Commissioner, Department of Mental Hygiene, State Office Bldg., Albany, will receive bids until June 29, for the construction of a cold storage building at the St. Lawrence State Hospital.

N. D., Bismarck—State Bd. Control will take bids about July 21, for construction of 18 story, state capitol, including elevators, steam heating system, etc. Estimated cost $2,000,000. J. B. DeRemer, Grand Forks; W. F. Kurke, Fargo, and Holabird, & Root, 104 South Michigan Ave., Chicago, Ill. are architects.

O., Columbiana—Village Board of Control, is considering plans for construction of a municipal power plant. Estimated cost is $100,000.

O., Piqua—City, L. G. Whitney, city manager, awarded contracts as follows in connection with construction of power and light plant, boilers to Combustion Engineering Corp., 200 Madison Ave., $73,599; turbines to Elliott Co., Morris Bldg., Pittsburgh, Pa., $129,830; condensers to Worthington Pump & Machinery Corp., Rockefeller Bldg., Cleveland, $16,027.

O., Shelby—City, B. Fix, city clerk, taking bids until June 27 for the construction of a 1 story, municipal light plant addition. Estimated cost is $85,000. Froelich & Emery, Toledo Trust Bldg., Toledo, are architects.

Pa., Kittanning—Pittsburgh Limestone Co., Kittanning, plans construction of docks and limestone handling equipment. Estimated cost is $80,000.

Va., Quantico—Bu. Yards & Docks, Navy Dpt., Wash., D. C., will receive bids until June 22 improving refrigerating plant, power plant and laundry, at U. S. Marine Barracks. Specification, 6904.

Wis., Green Bay—Brown County, H. J. Neville, clerk, taking bids for construction of heating plant, including 1 pipe steam plant; 2-pipe steam plant and hot water system. Private plans.

B. C., Vernon—Kelowna Growers Exchange plans construction of a cold storage plant. Estimated cost is $34,000.

Equipment Wanted

Locomotive Boilers—Lahore, India—General Manager of North Western Ry., is in the market for 34 super heated and saturated locomotive boilers, both saturated and superheated types.

Generating Unit—Los Angeles, Calif. — T. Oughton, city purchasing agent, taking bids for generating equipment for Harbor steam plant, involving installation of a turbo-generating unit of 60,000 k.w., capacity, which may untimately be increased to 300,000 k.w.; the boiler equipment capacity from 575,000 to 700,000 lbs. steam per hour. In order to provide continuous service there will be 2 sets of water tube boilers, each with above rating, specifications call for 450 lbs. or 1,400 lbs. pressure per square inch. Bids will be taken both ways.

Switchgear Equipment — Montevideo, Buenos Aires, S. A.—State Electrical Supply & Telephone Administration will receive bids until July 25 for 10 transformer sub-station switchgear equipments of indoor type for 6600/200 volts, 50 cycles.

Mine Equipment — Butler, Pa. — Brier Hill Coal Co., C. H. Gould, egneral manager, Butler County National Bank, preparing plans and will soon take bids for mine tipple building and equipment including 400 ft. 30 in. belt conveyor feeder, vibrator, lowering equipment, crusher and auxiliary screens.

Power Plant Equipment—Austin, Tex.—University of Texas, Bd. of Regents, c/o J. W. Calhoun, comptroller, Austin, will receive bids until July 15 for power plant equipment, including installation of steam heating equipment in present power plant building, boilers, etc., for use of lignite fuel.

POWER

Established 1884—McGraw-Hill Publishing Company, Inc.

ELY C. HUTCHINSON, *Editor*

VOLUME 75 JUNE 28, 1932 NUMBER 26

POWER—

a Monthly

ONE OF the most encouraging signs of the day is the virile reaction of men to the business conditions. No use to spend time explaining that, compared with 1929, business is off. Those who are marching strongly to the better days ahead, have forgotten all that. They have revised their plans, readjusted their conception of objectives and are set ruggedly to waste no energy on "what has been" but to put all the spirit into "what shall be."

POWER has advocated these principles unremittingly and would fail of consistency if it allowed any others to shape its own policies and objectives. In keeping with the times *Power* will, commencing with the issue of July 12, be published once a month, the weekly numbers ending with this issue.

THE EIGHT points that "*Power* Stands for" are of course a fundamental and irrevocable part of *Power's* existence. They will not be changed. Brisk treatment of the major subjects of combustion, steam engineering, oil engines, hydro power and all the others will continue without abatement. The parts of the magazine devoted to the interests of the operating and practical aspects of power generation will have a proportionately generous space allotment.

THERE will, however, be this difference: The reader will find articles to be in greater concentration, particularly edited for the rapid absorption essential to readers who would keep abreast of important developments in the field, without lost motion.

WITHAL, the editorial pages in the monthly publication will retain all of the welcome to the reader that has characterized *Power's* past forty-eight years of publication. Subscribers of long standing will have no feeling of strangeness.

IN SHORT, the editor's advice to industry to improve quality will be epitomized in *Power,* the monthly, the standards of which will steadfastly keep faith with its readers and the industry it serves.

Remember—

JULY TWELFTH

EDITORIALS

Employment, Profit, Taxes

"To chisel," says the dictionary, is "to pare, to gouge." Colloquially it is "to cut close, as in a bargain." One hears the word used a great deal these days, in all its various shadings. It has been revived evidently as a neat and expressive means of describing one of the most contagious and virulent epidemics of the depression.

Its symptoms are buying avarice and selling cowardice, accompanied generally on the one hand by a feverish desire to take advantage of a demoralized and hungry industry, and on the other, by an inordinate scramble for orders regardless of consequence.

Business knows better, yet seemingly finds itself powerless to administer its own antidote. If ever a doctor were needed, it is now! After all, industry has been one of the nation's big tax payers and its importance as an employer of labor is well known. Its success, then, must be conceded as of vital concern to the general welfare.

It must receive orders with a reasonable proportion of profit if it is to employ labor and pay the taxes expected of it. It should be legally encouraged to study its own problems in these respects and to a proper extent fit its production and sales policies to the community needs.

Industry, like any other indispensable group, is entitled to a reasonable return on a fair capital investment.

But when?

Let's Go!

In an interview shortly after his retirement from the R.F.C., General Dawes expressed his opinion that the turning point in the depression has been reached. Coming from one whose connections and opportunity for observation are so advantageous this viewpoint is important.

His further statement that the recovery will start from the bottom and work upward, not from the top, downward, has a special significance to the power field. It confirms what *Power* has long been pointing out, namely that the smaller industries, with their lower overheads and ready adaptability to what the market offers in improved equipment and methods, have a real opportunity today.

Economies in power cost, heat for processing, methods of control and the like, are offering immediate and extraordinary profits. Not that these offerings were not there for the plucking long ago, but in the rush of a business plenty they have been almost sinfully neglected.

Now, the leading consultants have time on their hands, and they are devoting it to the interests of the smaller power plants. And where their advice has been followed, large savings have resulted.

Yet, any number of cases are known where savings are awaiting the decision of timid boards of directors who lack gumption or faith in their country's ability to come back.

Presumably these people have no sense of social responsibility. They would go hungry while the food spoils in the larder, for fear there will be none on the morrow.

Our National Headache

An erstwhile business man, arm tied up, eye bandaged, face black and blue, was accosted by a friend with the query, "Well, what on earth happened to you?" His reply was, "I was out on a party last night, and I jumped through a plate glass window." "But what on earth did you do that for?" The reply bears consideration: "I haven't the slightest idea now, but at the time it seemed like the right thing to do!"

The party, the seeming "right thing," and the "morning after" always come in that order. The story is Charles F. Kettering's, and was told at the recent N.E.L.A. convention. Then he concluded with: "I should like you to . . . accept your problems as they are today. And remember that you've got to solve them and that you can't keep them from being here. But go at those problems not as though they were forced upon you unintentionally, not as though they were a burden. Go after them with open minds, bring the engineers in here, look at these new problems—and go ahead!"

We had our party, the window broke with us in 1929, and we've been through a rather sick "morning after." We made our mistakes, but they are over and done with now. The sooner we open our minds to new ideas and to betterment of old ones, the sooner we shall lose our national—and international—headache.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

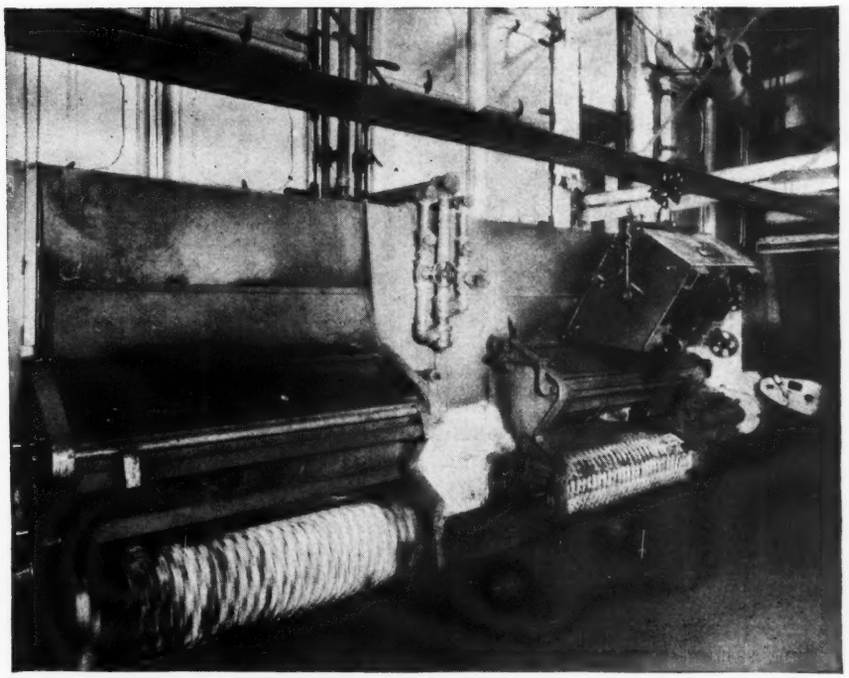


Fig. 1—Front view of chain-grate stokers installed under 3,000-sq.ft. water-tube boilers

$30,000 Saved Yearly

In Operating Costs at Gimbel's

By A. L. COLE

REHABILITATION of an old plant offers one of the surest opportunities for reducing the cost of steam and power. A good demonstration of what can be done in this respect is found in the recent changes made to the plant of Gimbel Brothers Department Store, New York City. By replacing hand-fired grates with chain-grate stokers, reconditioning the heating and refrigerating systems, and a general tuning up of operation, an operating saving approaching $30,000 a year is being made. This saving was made possible through the cooperation given the plant engineer, who made the recommendations, by the store management.

The group of buildings supplied with heat and power by the Gimbel plant, in addition to the Gimbel store proper between 33rd and 32nd Streets, includes Saks store, 34th St. and 6th Ave., and an administration building on the south side of 32nd St. Formerly the boiler plant at the store supplied the heating and some power requirements of the two stores, while the administration building had a boiler plant of its own.

To get a clearer picture of the changes made in the equipment and methods of operation which resulted in the decrease in operating costs, some of the conditions existing at the time the present plant engineer took charge, about fifteen months ago, will be briefly outlined.

The plant was 22 years old, and few changes had been made in the equipment or methods of operation during its life. All auxiliaries of the same type, or rather for one service, were either all-steam or all-electric drive, making it difficult to effect any kind of a heat balance.

During the heating season from September to May, a total of ten firemen were employed at an expense of approximately $300 a week. Eight of these firemen were employed at the store plant and two at the administration building. During the summer months, the number was reduced to eight.

The boiler installation at the store consisted of six 3,000-sq.ft. horizontal water-tube boilers, hand-fired with No. 1 buckwheat coal costing $6.25 a gross ton. The same fuel was used at the administration building. The average boiler efficiency at the store plant was about 58 per cent.

Two 40-ton absorption machines, one 15-ton motor-driven compression machine and two steam-driven brine pumps comprised the refrigeration equipment. The absorption units supplied refrigeration service throughout

the store, while the compression unit supplied refrigeration to the drinking water system. This arrangement made it necessary to operate at least one machine on each system. The operation of the absorption system had not been satisfactory for some time, it being impossible to maintain the proper temperatures in the cold storage rooms. This trouble was found to be mostly due to the brine-pump suction tank being practically devoid of brine. Furthermore, with this shortage of brine no advantage was being taken of the hydrostatic head on the system, necessitating working of the brine pump under a pressure differential of approximately 135 lb. with a consequent increase in steam consumption.

Three motor-driven pumps taking water from the city main supplied four house tanks, which in turn supplied water to hot-water generators of the instantaneous type, using live steam, and to all floors with the exception of three floors above and below grade. City water is used in the condensers of the refrigerating system. The water, after leaving the condensers, is discharged into the house pump suction tank, from which it is pumped to the house tanks.

A preliminary inspection of the heating system, which was of the usual two-pipe vacuum-type, disclosed that 90 per cent of the traps were completely out of commission, the internal elements having been removed, and the other ten per cent were in poor operating condition. Steam was blowing through the returns and an excessive amount of city water was being used to condense the steam, resulting in a big waste of hot water to the sewer. Furthermore, no vacuum could be maintained on the system. All high-pressure traps were in bad states of repair and were found to be blowing steam through to the return-receiving tank and atmosphere.

After an exhaustive survey of the plant had indicated that large savings could be made, a definite program of rehabilitation was laid down. The work was started on March 1, 1931.

One of the first changes was the installation of new traps on all radiators of the heating system; when this had been done a vacuum of 3 to 8 in. could be maintained with a consequent saving in steam. This was followed by a revamping of the refrigerating system.

As previously mentioned, the brine system was practically devoid of brine. It required approximately 2,400 lb. of calcium chloride to fill the system to the required level. When this was done, the differential on the brine pumps was reduced from 135 to 40 pounds.

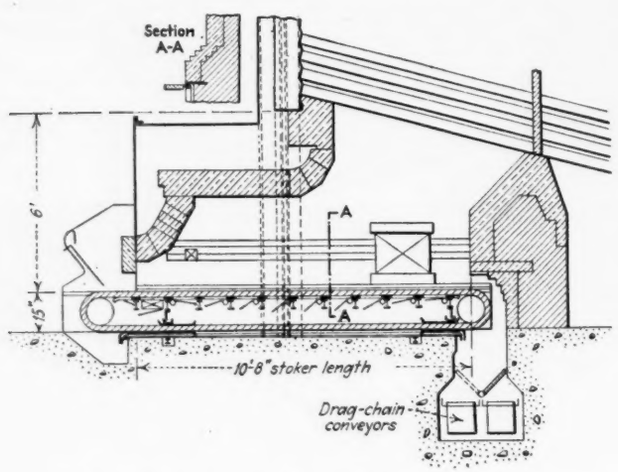


Fig. 2—Cross-section of boiler and stoker setting

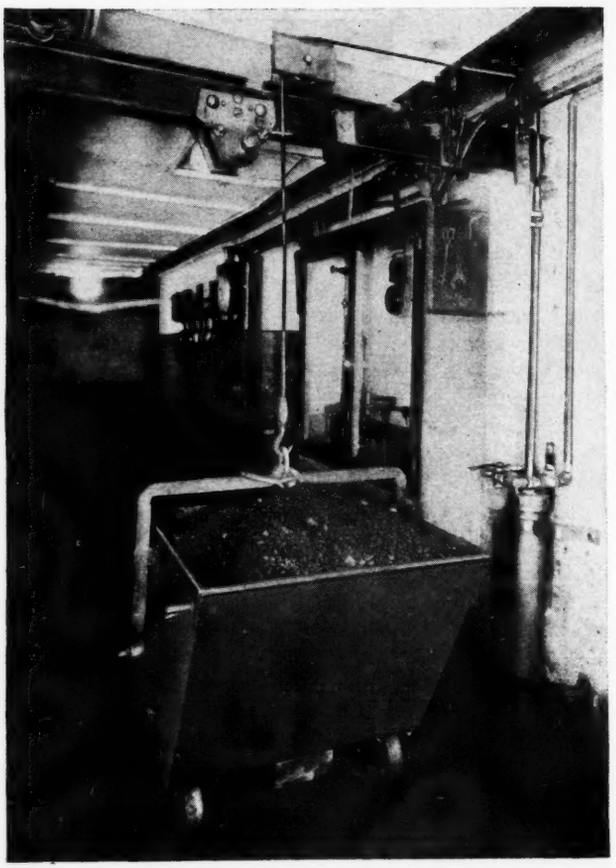


Fig. 3—Coal bucket is lifted to mono-rail trolley by hydraulic hoist

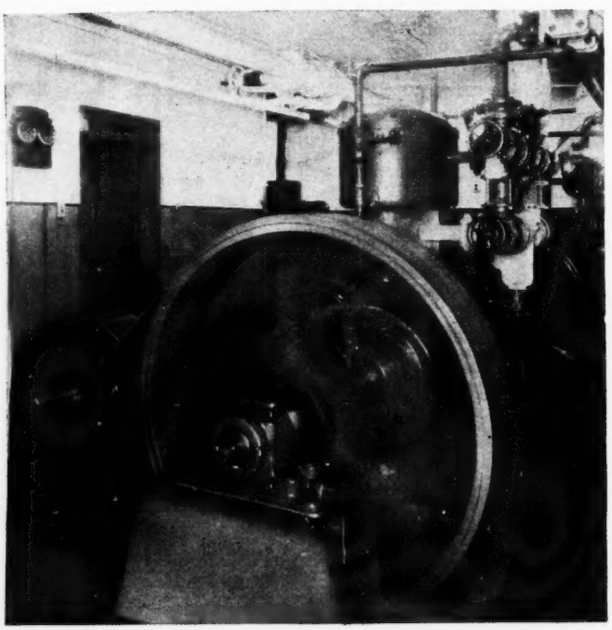


Fig. 4—Motor-driven compression refrigerating units

The two absorption machines were later replaced by two motor-driven compression machines and all three units were interconnected so that any one machine could take care of the complete refrigeration service, or two or three units could be operated in parallel as the service demanded. These changes reduced the operating labor charges for the refrigerating plant from $240 to approximately $50 a week. This change, together with the

electrification of some equipment that had been entirely steam driven, permitted the complete boiler plant to be shut down over the week-end for necessary repairs.

The 15-ton unit is sufficient to take care of the entire refrigerating requirements during the winter months. The present plans are to add a steam drive to one of the 30-ton machines, thus giving a dual drive. This will further simplify the control of the heat balance of the plant.

The original motor-driven house-service pumps were replaced by a steam-driven unit, and the instantaneous heaters, which utilized live steam, were replaced by a low-pressure storage heater utilizing exhaust steam. A considerable saving was made in the consumption of city water by changing the service water piping system. As stated previously, the three floors above and below grade were served directly from the city mains, while the other floors were supplied from the house tanks. With this arrangement a large amount of water used in the refrigerating condensers had to be discharged to the sewer. By transferring the service of these six lower floors from the city mains to the house tanks, the waste of water was materially reduced. Previously live steam had been piped to the Saks store and water heated on the premises. Under the present arrangement all water is heated in the Gimbel power plant and pumped to the various services in the three buildings.

The major improvement made at the plant was the installation of stokers under three boilers which formerly were equipped with stationary grates. After an exhaustive study of prevailing conditions, it was decided to install chain grates to permit the use of a cheaper grade of coal. A cross-section of the setting is shown in Fig. 2. The coal now being used is a slack semi-bituminous having a heat value of 14,200 B.t.u. This coal is purchased at a saving of approximately a dollar a ton over that formerly used with hand firing.

As building limitations did not permit raising the boilers, the necessary increased combustion space was obtained by excavating about 15 in. and extending the

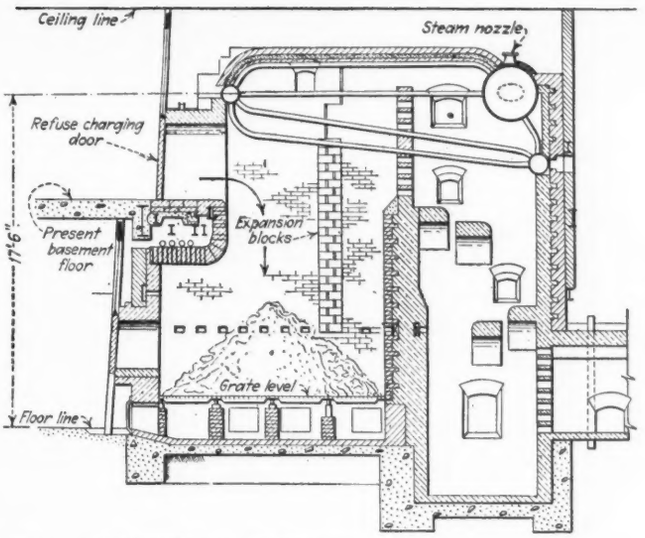


Fig. 5—Cross-section of incinerator with waste-heat type of boiler

furnace forward about 4 ft. A flat suspended arch forms the top of this section, and an ignition arch encloses the end above the grate. The bridge wall was rebuilt to conform with standard stoker practice. Control of the forced-draft air through the grate is provided by a damper for each foot of grate length.

Refuse falling from the rear of the stokers is drawn horizontally by duplicate drag chains. These discharge to a similar chain placed parallel with the boilers, which elevates the refuse to a standard ash can at the boiler floor level. The refuse is directed to either chain at the rear of the grate by means of a swinging damper pivoted at a point between the chains.

Formerly all coal was delivered to the firing floor in wheelbarrows. With the installation of the stokers a monorail trolley with tipping bucket was provided, as shown in Fig. 3. The bucket, holding 600 lb. of coal, is raised from the floor to the trolley by a hydraulic hoist. The stokers are motor-driven through a variable-speed transmission. Main dampers and forced draft air are under automatic control.

Operations of the stokers was started Dec. 12, 1931. The saving resulting from the use of cheaper coal, improved efficiency on the boilers together with the reduction in labor, has far exceeded the estimates. For the first four months of operation, the savings have been more than $13,000.

Another important factor in the reduction of operating costs was the replacing of the old incinerator with built-in economizer section with a modern incinerator and waste-heat type boiler of approximately 1,000 sq.ft. of heating surface. A cross-section of the unit is shown in Fig. 5. This waste-heat boiler is operated in parallel with the main boiler units, being connected to the steam header through a non-return stop and check valve. Based on the present rate of refuse disposal, it is estimated that between 8.5 and 9.5 million pounds of

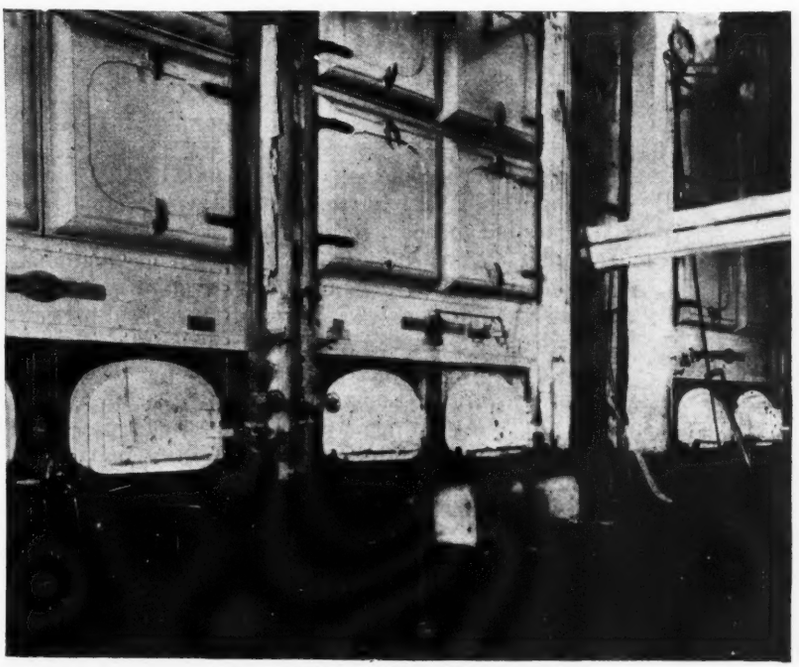


Fig. 6—Original installation of water-tube boilers with stationary grates

New Equipment Installed in Gimbel's Power Plant

Stokers, chain-grate, forced-draft	Illinois Stoker Co.
Drives, variable-speed transmission	Reeves Pulley Co.
Motors	General Electric Co.
Forced-draft fans	Buffalo Forge Co.
Motor-drive	General Electric Co.
Ash conveyors, chains "Promal"	Link-Belt Co.
Ash conveyors and installation	Girtanner Engineering Corp.
Furnace arches	American Arch Co.
Boiler settings	Fredk. Page Contracting Co.
Combustion control, forced-draft	A. W. Cash Co.
Ice machines, 9x9	Frick Co.
Motor drives	Crocker-Wheeler Co.
Brine pump	Chicago Pump Co.
Motor drives, 10 hp.	Westinghouse Electric & Manufacturing Co.
Drinking water pump	Chicago Pump Co.
Motor drive	Westinghouse Electric & Manufacturing Co.
Incinerator construction	Fredk. Page Contracting Co.
Incinerator boiler	Erie City Iron Works
Non-return stop valve	Lunkenheimer Co.
Feed water regulator	Kieley & Mueller, Inc.
Water column, inclined gage	Reliance Gauge Column Co.
Blow-off valves	Everlasting Valve Co.

steam will be generated a year by this unit burning refuse alone, representing a saving of between 400 and 500 tons of coal.

In the old incinerator all refuse had to be lifted from the lower floor level and thrown into the furnace, requiring the services of two men. In addition, two extra men were employed to operate a separate baling machine for the waste paper. In the new installation the refuse is pushed horizontally into the furnace at the second floor level and drops to the grate, thus reducing to a minimum the work involved in firing this unit. All waste paper is now burned with the other refuse, and one man does the work formerly done by four.

A further saving was made by a general overhauling of the piping and valves. Leaking high-pressure traps were repaired where possible and the others replaced. Daily inspection is now made of all traps by the watch engineers.

Electric energy is supplied by the public utility at 240 volts d.c. The power is purchased under contract with a definite demand rate. The demand is kept down by regulating the motor-driven equipment where possible so that during peak hours, between 1 and 5:30 P.M., the minimum number of motor-driven units is operated. Considerable reduction in power demand has been made by regulating the operation of the passenger elevators so that only the actual number of elevators required for satisfactory customer service are in operation.

All new piping and electrical construction in connection with the rehabilitation program was done by the maintenance staff under the supervision of the plant engineer.

The foregoing is a brief resume of the more important changes made in the plant to date. More are contemplated. When the present plans have been completed it is expected that the operating saving will approach $40,000 a year.

▼ ▼ ▼

Economics of Building Heating With Refrigeration Equipment

By B. H. JENNINGS
Lehigh University

The use of refrigerating equipment for building heating has been discussed previously in several issues of *Power*. This article compares the operating and first costs of this system with the costs of other methods of heating

THE POSSIBILITY of heating with reversed heat engines or refrigeration systems has been known since the middle of the last century, but only in the last few years has the cycle been considered from a commercial point of view. The broad application of air conditioning for industrial processes and for public buildings has given refrigeration system heating a considerable impetus. The installation of refrigeration heating in connection with direct electric heaters in the new office building of the Southern California Edison Company[1] in Los Angeles is the first large plant of this type.

Wherever a refrigeration compressor operates the possibility of this type of heating exists. The compressor, which in summer is the nucleus of a cooling system, can in winter become an element of a heating system, drawing its heat largely from the cold winter atmosphere. The question to be solved in every case is the economic feasibility of such a system for a given installation.

A diagrammatic layout of a refrigeration heating system is shown in Fig. 1. The temperatures and pressures given there are suitable for operation with ammonia as a refrigerant. In this layout the motor-driven compressor delivers ammonia at 212 lb. per sq. in. abs. at a temperature of 193 deg. F. This hot vapor passes to a double pipe counterflow condenser where it is cooled to 100 deg., condensed at that temperature and sub-cooled to 80 deg. The 80-deg. liquid refrigerant leaving the receiver passes through the expansion valve, where it drops in pressure and temperature to 59.7 lb. and 30 deg. F. In the evaporator the 30-deg. ammonia is changed to a vapor in receiving heat from 40-deg. atmosphere. This 30-deg. vapor then returns to the compressor, and the cycle repeats itself. Water at 95-deg. leaving the ammonia condenser passes to a finned-tube heater

[1]See *Power*, June 16 and Sept. 8, 1931.

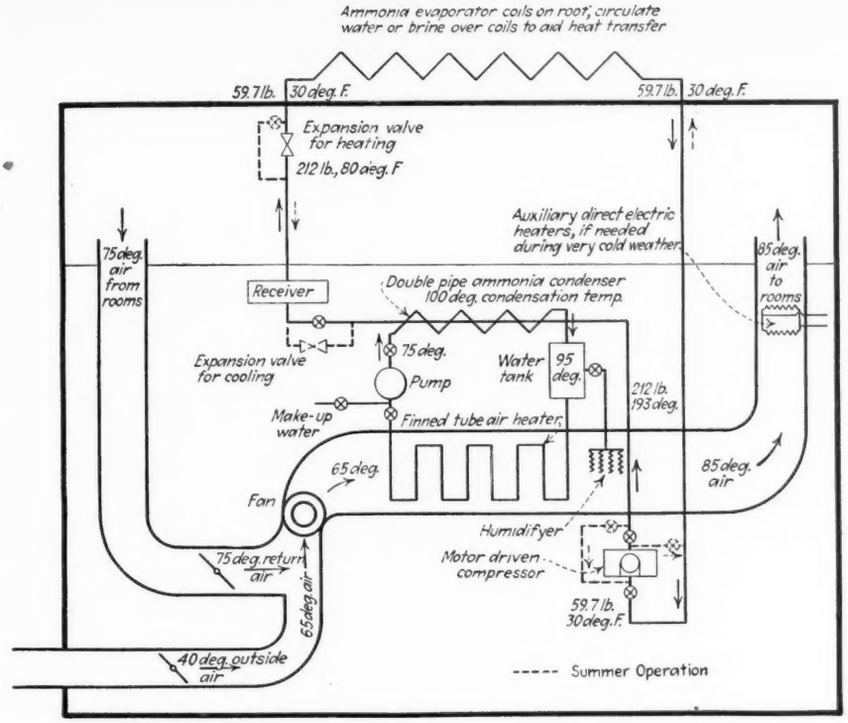


Fig. 1—Diagrammatic layout of refrigeration plant for heating in winter and cooling in summer

in the air heating duct where the water is cooled to 75 deg. in giving up its heat to the air flowing by. The hot air passes to the rooms to be heated. The dotted lines and arrows show how the system can be reversed in warm weather for cooling and air conditioning.

To provide some idea of the heat quantities involved, a calculation using the above data has been made. This is worked through on a theoretical cycle which can be modified by a suitable factor to give actual conditions of operation. The cycle is shown on a temperature entropy diagram, Fig. 2. On this diagram areas can be used to represent heat quantities. Starting with dry saturated vapor (a) entering the compressor at 59.7 lb. per sq. in. abs. and 30 deg. F., compression to 212 lb. abs. requires 78 B.t.u. as work and gives theoretical temperature of 193 deg. F. at the end of compression (b), to cool the vapor to the condensation temperature of 100 deg. and to condense it at this temperature, 544 B.t.u. must be removed. This heat passes into the water and is available for heating. Sub-cooling the liquid ammonia to 80 deg. yields an additional 23 B.t.u. The 212-lb., 80-deg. liquid at (e), with 132 B.t.u. total heat, enters the expansion valve and throttles to 59.7 lb. abs. and 30 deg. Its condition is represented at (g). To change this into dry and saturated vapor at (a), 489 B.t.u. must be absorbed from the atmosphere. This heat absorbed from the atmosphere, plus the heat equivalent of the work of compression, 78 B.t.u., equals the useful heat removed by the condenser water, 567 B.t.u.

In this cycle 567/78 or 7.3 times as much heat is available in the condenser as was supplied from the electric mains. The areas indicated show graphically the relatively large amount of heat that can be absorbed from the atmosphere, compared to that which must be supplied by the compressor as work. When power to run auxiliaries, deviations from the cycle, etc. are considered about four times as much heat is available as is supplied electrically. In general about 50 per cent of the heating coefficient can be realized. To supply 10,000 B.t.u. by this method.

$$\frac{10{,}000 \times 78}{567 \times 341 \times 0.50}$$

or 0.80 kw.-hr. are required.

It is evident that varying outdoor temperatures will change the ratio of work required (electrical input) to heat delivered. This ratio for outdoor temperatures varying from 60 to 0 deg. F. have been worked out and are shown in Table I. It should be noted that the higher the atmospheric temperature the more economical the system is per B.t.u. delivered as heat. In the table the cost of furnishing 10,000 B.t.u. by various methods has been calculated for comparison. The fuel and electrical costs are purely arbitrary and will vary greatly in different sections, but assumed prices are such that they can easily be modified for definite fuel prices. The assumption that one-half the ideal coefficient of heating can be realized at the point of utilization is amply liberal for most systems. Over-all efficiencies by other heating methods range over very wide limits. Small coal-, oil- or gas-fired boilers may give from 55 to 80 per cent efficiency, whereas direct electric or gas heaters may give almost 100 per cent.

It is evident from Table I that, considering fuel and electricity costs alone, a refrigeration heating system can show a favorable balance as compared to other heating methods. This is particularly true where atmospheric temperatures seldom drop below freezing.

In Table II, the investment cost of refrigeration heating systems as compared to other systems is given. Figures in this table are based on analyses of actual costs of refrigeration-equipped air-conditioning installations with the cost of the additional equipment or capacity required for heating added in. It appears in every case that refrigeration heating installation costs run from

Fig. 2—Temperature entropy diagram for ammonia, to show heating possibilities

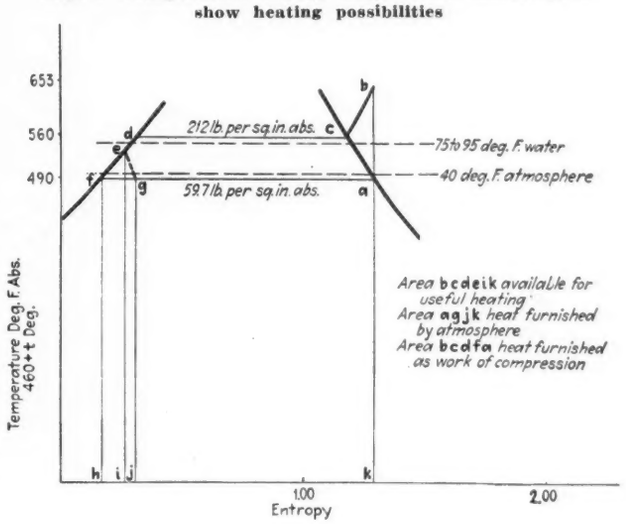


TABLE I — COST OF OPERATING REFRIGERATION HEATING SYSTEM UNDER VARIOUS OUTDOOR TEMPERATURE CONDITIONS, WITH COMPARATIVE COSTS OF OTHER METHODS OF HEATING

Outside air temp., deg. F.	60	50	40	30	20	10	0
Ammonia temperature in evaporator coils, deg. F.	50	40	30	20	10	0	—10
Corresponding ammonia pres., lb. abs.	89.2	73.3	59.7	48.2	38.5	30.4	23.7
Hot air temperature required for heating, deg. F.	85-90	85-90	85-90	85-90	85-90	85-90	85-90
Ammonia temperature in condenser coils, deg. F. saturated.	100	100	100	100	100	100	100
Corresponding ammonia pres., lb. abs.	212	212	212	212	212	212	212
Useful heat available in condenser, B.t.u. per lb.	545	555	567	578	590	605	620
Heat absorbed from atmosphere, B.t.u. per lb. ammonia	493	491	489	486	483	480	477
Heat supplied as work of compression per lb. ammonia	52	64	78	92	107	125	143
Coefficient of heating, B.t.u. for heating divided by equivalent B.t.u. supplied as work	10.5	8.7	7.3	6.3	5.5	4.8	4.3
Kw.-hr. required per 10,000 B.t.u. delivered as useful heat	0.28	0.34	0.40	0.46	0.53	0.61	0.68
Cost of 10,000 B.t.u. by above system at 1c. per kw.-hr. Coefficient of heating assumed 50 per cent realized at heaters, cents	0.56	0.68	0.80	0.92	1.06	1.22	1.36
Cost of 10,000 B.t.u. by direct electric heating at 1c. per kw.-hr., cents	2.93	2.93	2.93	2.93	2.93	2.93	2.93
Cost of 10,000 B.t.u. — 12,000-B.t.u. coal at $10 per ton, 65 per cent over-all efficiencies, cents	0.64	0.64	0.64	0.64	0.64	0.64	0.64
Cost of 10,000-B.t.u. — 20,000-B.t.u. oil at 8c. per gal. 75 per cent over-all efficiencies, cents.	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Cost of 10,000-B.t.u., 500-B.t.u. per cu.ft. gas at 50c. per M. 75 per cent over-all efficiencies, cents	1.33	1.33	1.33	1.33	1.33	1.33	1.33

three to five times as much as for standard heating equipment. Maintenance costs also are probably higher for the refrigeration heating system. Wherever air conditioning assumes its share of the fixed charges, refrigeration heating investment costs drop to an average of about three times as much as the fixed charges on standard heating equipment.

In many cases air-conditioning equipment must be installed. For such cases it is pertinent to investigate how much additional cost the refrigeration heating entails in the case of an already installed air conditioning system or for a proposed system. The last item in Table II shows that in such a case the investment charges for refrigeration heating may be even less than for standard heating equipment.

The results brought out in Tables I and II largely answer the question of the economic feasibility of refrigeration for heating. In general refrigeration heating is impracticable where atmospheric temperatures run below 32 deg. F. during much of the heating season or where the fixed cost of equipment cannot be shared.

The temperatures available for heating by this method can seldom economically exceed 120 deg. F. Such low temperatures for heating necessitate large-size heat transfer equipment, radiators, hot air ducts, etc., with corresponding high cost and excessive space requirements. The use of panel heating in a building would obviate some of these difficulties.

At present it appears that in almost every case combustion of fuel for heating furnishes the most economical solution of the heating problem. However, wherever it is necessary to install refrigeration equipment for another purpose the amount of extra cost for refrigeration heating equipment should be investigated, especially in mild climates and where fuel costs are high. Where electric power is cheap enough to consider for direct electric heating, refrigeration heating equipment should be investigated. If centralized refrigeration in large apartment houses comes into use in replacing domestic refrigerators, by slightly increasing the

TABLE II — INVESTMENT COST OF REFRIGERATION HEATING SYSTEM COMPARED WITH OTHER SYSTEMS

Small Domestic Installation

Cost of heating system of steam, hot water or hot air fired by coal, gas or oil	$800 to $1,000 Avg. 900
Yearly investment cost for above allowing 9 per cent interest and maintenance costs	81
Cost of refrigeration heating and air-conditioning system	2,500 to 3,500
Yearly investment cost for the preceding item allowing 12 per cent for interest and maintenance costs	360
Allocating 7 months to heating and 5 months to air conditioning; investment cost per year for refrigeration heating becomes	210
Direct electric heating investment costs vary from $300 for direct radiant heaters in every room to about $1,500 for central system using hot water storage and off peak power	300 to 1,500
Investment cost for direct electric heating allowing 9 per cent interest and maintenance	27 to 135

Medium-Size Apartment House or 1,800 Seat Theatre

Cost of heating system for steam or hot air; coal, gas or oil as fuel	$12,000
Yearly cost for above allowing 9 per cent interest and maintenance costs	1,080
Cost of refrigeration heating and air conditioning system	50,000
Yearly investment cost for the preceding item allowing 12 per cent for interest and maintenance costs	6,000
Allocating 7 months to heating and 5 months to air conditioning, investment cost per year for refrigeration heating becomes	3,500
Amount of the total cost of above system required for heating only	8,000
Yearly investment cost on heating part of system alone, allowing 12 per cent for interest and maintenance	960

size of the installed central refrigeration system the apartment building can be heated by refrigeration methods under low fixed charges. Any refrigeration heating system could be made practically automatic so that labor charges would not run higher than for the standard systems. The most serious drawback to the system is high cost of equipment. This item might be largely reduced if mass production of equipment were undertaken.

▼ ▼ ▼

Additions to Hudson Avenue Equipment List

THE May 31 number of *Power,* devoted to the Hudson Avenue station extension, Brooklyn Edison Company, included a tabulation of principal mechanical equipment. For lack of space some important items were omitted. The following are here listed as additions to that table:

Boiler gage glasses . . . Reliance Gauge Column Company
Firebrick, tile, insulating brick and other insulation for boilers, furnaces and settings:
Ballard, Sprague & Co. (contractor)
McLeod & Henry Co.
Armstrong Cork & Insulation Co.
Henry Mauer & Son
North American Refractory Co.
Philip Carey Co.
Refractory & Engineering Corp.
General Insulating & Manufacturing Co.
R. A. Keasbey & Co.

The type arrangement used under the heading "Mechanical Meters and Instruments" listed the instruments and meters furnished by each manufacturer in a full line (followed by the manufacturer's name) and in the indented lines immediately below. For example, the following equipment was furnished by the Bailey Meter Company: two electrically operated flow meters (boiler feed); two electrically operated flow meters (condenser make-up); eight sets of boiler meters (boiler panels)."

Steam-Turbine Plant Practice in the United States*

By VERN E. ALDEN and W. H. BALCKE
Power Engineer *Chief Power Engineer*
Stone & Webster Engineering Corp.

From the great volume of available data on the design, equipment, service requirements and operating results of the steam-electric generating stations serving the larger power systems in the United States, the authors have endeavored to present a cross-section of existing turbine-plant practice

AMERICAN steam-turbine plant practice has in the main been dominated by the desire to gain four objectives:

1. Improvement in reliability in order that generating capacity may, to the maximum extent possible, be available for service when needed.
2. Reduction in fuel consumption per kilowatt-hour of net station output.
3. Reduction in the over-all investment per kilowatt of system peak load carried.
4. Reduction in cost of operating labor and maintenance.

The most significant trends are the increase in the size of turbine-generators and the increases in steam pressure and temperature. Figs. 1, 2 and 3, somewhat modified from the form as presented in an earlier paper,[1] may help to visualize the rate of progress. The cross-hatched areas show the limits within which representative steam-station practice has fallen. An attempt has been made to indicate what might be called conservative practice, or trend, by means of a curve drawn through each cross-hatched area. The horizontal lines extending from 1928 to 1932 in Figs. 2 and 3 indicate the views of several schools of thought as to the best steam pressure and temperature.

Reheating

Another important development has been the use of a single stage of reheating to raise the temperature of the steam, after partial expansion, to its initial temperature or slightly higher. The development dates from the initial operation early in 1925 of two 40,000-kw. turbine generators in the Philo Station of the Ohio Power Company, with steam delivered to the turbine throttle at a pressure of 550 lb. per sq.in. gage and 725 deg. F., the steam being withdrawn from the turbine after being expanded to 155 lb. per sq.in. gage, returned to the boiler plant, reheated to 725 deg. F., then expanded through the remaining turbine stages to the condenser. Since this initial development there has been installed, or is now in the course of construction, in 19 generating stations in the United States a total of 2,800,000 kw. of turbine capacity for operation on the reheating cycle. All of this capacity is for operation at initial steam pressures of 550 lb. per sq.in. gage or higher, and 1,150,000 kw. is for operation at pressures of 1,200 lb. per sq.in. gage or higher. For approximately 80 per cent of this capacity flue-gas reheaters are used, and for the remaining capacity high-pressure steam reheaters are used. Where high-pressure steam reheaters have been used, the reheat temperature has been limited to approximately 500 deg. F. Approximately 30 per cent of the capacity of all turbines 20,000 kw. and larger placed in service and ordered since Jan. 1, 1925, has been designed for operation on the reheating cycle.

During the past five years there has been an appreciable amount of sporadic operation of large turbines with steam at temperatures from 750 to 800 deg. F. The limit of good practice was generally considered, however, to be 750 deg. F. at the throttle. Orders were placed in 1929 with three manufacturers for turbines to operate with steam at temperatures from 800 to 850 deg. F. An experimental installation of a 10,000-kw. tandem-compound condensing turbine is now in operation with steam temperatures ranging up to 1,000 deg. F. at 390 lb. per sq.in. gage in the Delray No. 3 Station of the Detroit Edison Company.

Considerable experience has been had in the past five years with large turbines operating on a non-reheat cycle with steam delivered to the throttle at pressures of 550-600 lb. per sq.in. gage and temperatures of 675

*Excerpt from a paper contributed by the Power Division for presentation at the Semi-Annual Meeting of the American Society of Mechanical Engineers, Bigwin Inn., Lake of Bays, Ont., Canada, June 27-July 1.

[1]"Rehabilitation of Steam Power Plants," by C. F. Hirshfeld, Vol. 48, Quarterly Transactions, American Institute of Electrical Engineers, Oct. 1929.

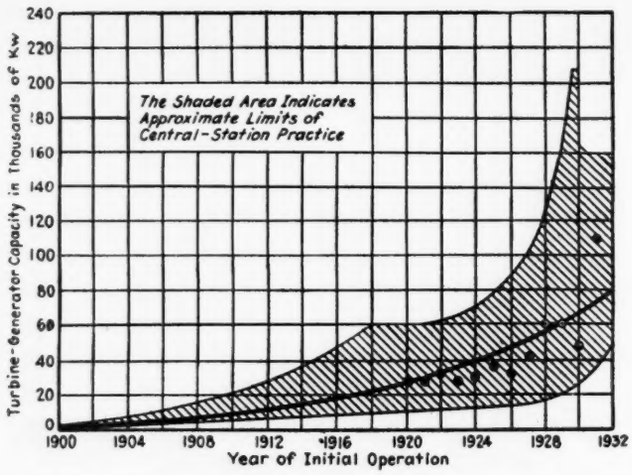


Fig. 1—Increase in capacity of turbine-generators
Graph shows both single- and multi-cylinder units; circles are average turbine capacities

to 725 deg. F. The percentage of moisture in the turbine exhaust is about the same for this condition as with steam delivered to the turbine throttle at 200 lb. per sq.in. gage and 480 deg. F. There has been some weight of opinion to the effect, however, that for these operating conditions the friction losses and blade erosion in the low-pressure stages, resulting from the relatively high moisture content of the steam, were too high for good practice. The raising of the steam temperature to the still higher value of 825 deg. F. makes it possible with a steam pressure of 650 lb. per sq.in. gage and no reheat to limit the moisture in the steam at the exhaust to the somewhat more reasonable value of approximately 12.5 per cent. This combination, having none of the complications of reheat, is a most attractive one. The new Sheboygan Station of the Wisconsin Power & Light Company and the extension to the Burlington Station of the Public Service Electric & Gas Company of New Jersey are to operate with these steam conditions. The somewhat older Michigan City Station of the Northern Indiana Public service Company operates with steam delivered to the 60,000-kw. single-cylinder turbine at 650 lb. per sq.in. gage and 750 deg. F.

Multi-Stage Feedwater Heating

One of the most striking developments is the revival and almost universal acceptance since 1924 of the practice of multi-stage feedwater heating with steam extracted from the main turbines at a number of points during its expansion. It has become common practice to extract steam from the main turbines at from three to five points and to heat the feedwater to temperatures ranging from 250 to 425 deg. F., depending on the initial throttle steam pressure and the extent to which an economizer is depended upon to reclaim heat from the boiler-flue gases. This use of multi-stage feedwater heating places the generating station on a regenerative cycle, and insures the generation of the maximum amount of byproduct electrical energy (at an over-all heat rate of approximately 4,200 B.t.u. per kw.-hr.) from the steam extracted from the turbine at each of the different pressures. Aside from its marked effect in reducing the amount of heat rejected to the condenser circulating water and thus improving the over-all station efficiency, the use of multi-stage heating of feedwater with steam extracted from the main turbines has had a most important effect, as outlined later, in making it possible to increase the maximum capacity obtainable in single-cylinder turbines.

The marked trend toward use of multi-cylinder construction for the larger turbine units shows 20 cross-compound turbines,[2] 18 tandem-compound turbines and 35 single-cylinder turbines. The advantages of multi-cylinder construction are:

1. The lower leaving loss or residual kinetic energy in the steam resulting from the use of two or more sets of low-pressure blades, each having its own exhaust to the condenser, a design feature usually embodied in multi-cylinder turbines.

2. For a cross-compound turbine, the ability to operate the high-pressure section of the turbine spindle at high speed and the low-pressure turbine spindle at lower speed. This in turn permits a smaller diameter for the high-pressure casing and in other respects results in a more favorable mechanical design.

3. Where the generator design has limited the capacity

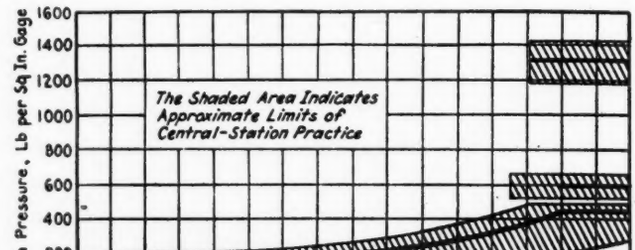


Fig. 2—Increase in steam pressure

of the unit, it has been possible to raise the maximum capacity by going to cross-compound construction with two or more generators.

4. Cross-compound construction has been advantageous in permitting the installation of very large units in an existing turbine room of limited width.

5. With multi-cylinder construction only a portion of the temperature drop due to complete expansion of steam occurs across each cylinder. This minimizes troubles from expansion of mechanical parts and tends to make it possible to start the turbine from a cold condition in less time.

6. Operating experience has tended to indicate that for a given capacity, with all other conditions the same, a multi-cylinder turbine will be available somewhat more hours per year than will a single-cylinder unit of the same capacity.

Single-cylinder turbine construction has, in general, the advantage of lower weight and lower investment in the turbine with its related equipment and structures for a given capacity. It tends toward more capacity per square foot of floor space in the turbine room, and undoubtedly does have an advantage in this respect over a tandem-compound machine of the same capacity. It is doubtful, however, if this advantage exists when the contrast is made between large single-cylinder turbines and large cross-compound turbines. The steeple cross-compound construction is extremely economical of floor space. Two 25,000-kw., two 50,000-kw., and one

[2]The turbines for operation at 1,200 lb. per sq.in. gage in the Edgar Station and the Lakeside Station are considered as compounded with the low-pressure turbines.

110,000-kw. turbines of this type are in operation at 1,200 lb. per sq.in. gage. The high-pressure turbine and its generator are, in the case of the four smaller machines, mounted on top of the generators for the low-pressure turbines. In the case of the larger unit a 55,000-kw. high-pressure turbine and its generator are mounted directly on top of the 55,000-kw. low-pressure turbine and its generator.

Single-Cylinder Turbines

Low-pressure blade areas and exhaust areas to the condenser are limited for single-cylinder machines, and this in turn either places a limit on capacity or makes it necessary to accept a higher leaving loss than that which can be rather readily obtained in a multi-cylinder design. The use of unidirectional double-flow exhaust blading, as embodied in the latest 60,000-kw. turbine installed in the Lakeside Station in Milwaukee, serves to increase the low-pressure exhaust blade area which can be obtained in a single-cylinder turbine. In general it has been the experience in the United States that the manufacturers have first built machines for the higher capacities as multi-cylinder machines, and later, as they have gained more experience and have had available better materials and better shop facilities, they have built single-cylinder turbines for these same capacities.

The capacity of a steam turbine of given dimensions is limited by the ability of the last row of spindle blading to pass steam at velocities which will correspond to a reasonable leaving loss.

There is a considerable group of engineers who believe that for maximum load, wintertime conditions of operation, and a 29-in. vacuum at the exhaust, a leaving loss ranging from 5 to 6 per cent of the heat available in the steam on the basis of adiabatic expansion is none too high. This is particularly true for the reason that the leaving loss for maximum-load summertime conditions of operation will, with the much lower specific steam volumes corresponding to lower vacuum for this same machine, be of the order of 2 per cent, and the average leaving loss for the year resulting from operation at partial loads and with vacuums correspoding to average circulating-water temperatures throughout the year will be of the order of 1.5 per cent. This willingness to accept turbines having a leaving loss approximately twice as great as that which has been considered in some cases to be good practice has made it possible to increase the maximum capacity of single-cylinder turbines by perhaps as much as 40 per cent. The acceptance of a higher per cent leaving loss is usually accompanied by the reduction on a per cent basis in the high-pressure packing and blade-tip leakage losses, the disk-friction losses, and other losses usually associated with the head end of the turbine, so that the decrease in over-all efficiency is not as much as might be expected even for wintertime operation.

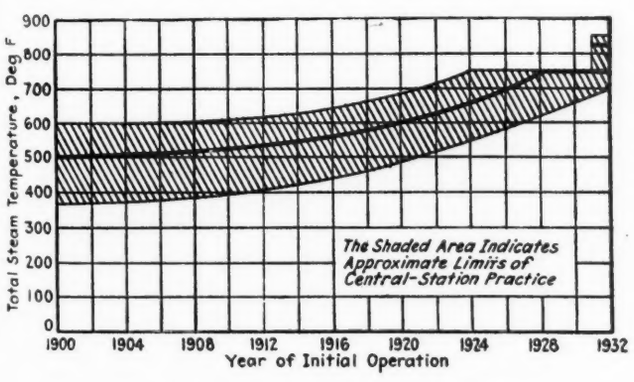


Fig. 3—Increase in steam temperature

During the last five years there have been installed nine turbines of 60,000-kw. capacity, one of 65,000-kw. capacity, five of 75,000-kw. capacity, and two of 80,000-kw. capacity, all single-cylinder machines. At least one of the manufacturers has expressed willingness to build single-cylinder turbines for operation at 1,800 r.p.m. and steam conditions of 650 lb. per sq.in. gage and 825 deg. F. at the throttle for a capacity of 100,000 kw.

No single-cylinder turbines for the expansion of steam from a pressure higher than 650 lb. per sq.in. gage to vacuum have been built in this country, and it appears unlikely that such machines will be built in the near future. Throttle pressures in excess of 650 lb. per sq.in. gage and steam temperatures in excess of 825 deg. F. seem to call for multi-cylinder construction. In general, it appears preferable to use multi-cylinder construction for the reheating cycle. There are, however, in Philo Station, Twin Branch Station, and Stanton Station, six 40,000-kw. single-cylinder condensing turbines operating successfully on the reheating cycle.

Condenser Installations

Surface condensers have increased in size as the turbines have increased in capacity, but the increase has not been nearly in proportion. The use of higher initial steam pressures and temperatures, reheating, extraction of steam from the turbine at a number of points for heating feedwater on the regenerative cycle, and an increase in the Rankine cycle efficiency ratio (the efficiency of converting heat available in the steam into electrical energy) have all contributed to decrease the amount of heat rejected to the condenser circulating water for each kilowatt-hour generated. This rejected heat has, on an average, over a period of the last 12 years, been decreased from about 10,800 B.t.u. to about 7,000 B.t.u. per kw.-hr. for gross generation. The area of condensing surface has, however, on the average decreased from about 1.6 sq.ft. in 1920 to 0.98 sq.ft. per kw. of turbine capacity installed in 1930, and the amount of condenser circulating water used has decreased from 2.0 g.p.m. to 1.44 g.p.m. per kw. of turbine capacity. For the eight large units operated initially in 1931, an average of 0.71 sq.ft. of condensing area was installed and 1.15 g.p.m. of condensing water circulated per kilowatt of turbine capacity. The use of single-pass condensers has increased very fast.

The trend toward the use of single-pass condensers has been an interesting one. The four design factors which have made it possible appreciably to reduce the amount of surface required to absorb a certain amount of heat from the turbine exhaust are, in the order of their importance:

1. Better arrangement of tube surface, insuring that effective work will be done by each tube.

2. The use of high water velocities through the tubes. If good performance is to be obtained, then for each square foot of condensing surface approximately 0.005 kw. must be expended on the job of scrubbing down to a reasonable thickness the dead film of water which clings to the inside wall of the tube.

3. The use of efficient air coolers, external to the condenser shell.

4. The use of smaller diameter tubes.

As designers have availed themselves of these factors, whether in two-pass or single-pass designs, there has been marked improvement in the effectiveness of the condenser, and later designs have been laid out with less surface to perform the same duty. With relatively less total surface and the use of tubes of smaller diameter and greater length, it has been found readily possible to arrange the surface for a single water pass, hold the water velocity through the tubes up to approximately 8 ft. per sec., and still not have the total circulating water exceed the amount which for maximum load conditions, will correspond to a temperature rise of from 12 to 15 deg. F.

Condenser Auxiliaries

Steam-jet air-removal pumps are being used almost universally. Their compactness and low cost and the ability to absorb conveniently the latent heat of the steam used into the feedwater heating cycle have commended them in spite of their relative inefficiency when contrasted to slow-speed, motor-driven, rotative dry-vacuum pumps.

Condensate pumps are usually designed to pump the condensate through at least one low-pressure extraction heater into an elevated surge tank or combined deaerator, extraction heater, and surge tank. In most modern installations both condensate pump glands are under the pressure of the discharge from the first stage in order to avoid air leakage into the condensate. It is almost universal practice to install two condensate pumps for each turbine, one being held in reserve. Opinion is divided as to whether variable-speed drive should be provided for the condensate-pumps.

The trend is toward the use of relatively slow-speed horizontal circulating pumps having efficiencies up to 85 per cent. It is fairly general practice to install two circulating pumps for each main turbine, their combined capacity being used for normal operation, but the capacity of one pump being sufficient for maximum load operation with some sacrifice in vacuum. Opinion is divided as to the necessity of variable-speed drive for the circulating pumps.

It appears that the trend with modern installations is or will be toward the maintained circulation, except for very light loads coincident with injection-water temperatures below 40 deg. F. of an amount of circulating water which will correspond to water velocities through the tubes of from 7 to 8 ft. per sec.

Feedwater Heaters

The multi-stage heating of feedwater by steam extracted from the main turbines is mainly accomplished in closed feedwater heaters, which are placed as close to the turbine as possible. Vertical heaters are quite generally used in the recent installations because of their space economy. In a number of stations one open heater of the deaerating type, having a considerable amount of water-storage capacity, is placed so as to deliver water to the suction of the feed pumps. The closed feedwater heaters are designed to operate on from 3 to 10 deg. F. terminal difference, and the open feedwater heater is designed for less than 1 deg. F. terminal difference. It is general practice to cascade the drips from one heater into the next lower heater and pump the combined drips back into the feed line at either one or two points.

In the larger condensing stations of modern design, the make-up to the boilers runs from 0.8 to 1.5 per cent, and this make-up is usually supplied through evaporators. Fresh water is usually fed to the evaporators, and in some cases this water is first passed through a water softener in order to minimize the scale troubles in the evaporator.

It is now rather general practice to deliver the low-pressure steam extracted from the main turbine to a single-effect evaporator and to deliver the vapor either into the next lower feedwater heater or to an evaporator condenser located just beyond the next lower extraction heater.

Boiler-Feed Pumps

Two or more boiler-feed pumps are usually grouped with and considered as a part of the turbine installation. In a number of cases the feed pumps have been selected so that one pump has sufficient capacity to handle the feedwater for a turbine of 50,000 kw. and in a few cases for turbines of even larger capacity. There is a school of thought which favors more conservative practice in connection with this most important auxiliary, as evidenced by the installation of six motor-driven boiler-feed pumps and four steam-driven pumps to serve the 208,000-kw. turbine in the State Line Station and by the installation of nine motor-driven pumps and two steam-driven pumps to serve the two 105,000-kw. turbines in the Powerton Station. It is rather general practice to group moderate-sized turbines of less than 40,000 kw. capacity in pairs and to install four boiler-feed pumps of equal capacity for each pair of turbines, one motor-driven and one steam-driven pump serving as reserve capacity. It is rather common practice to drive the boiler-feed pumps by means of variable-speed induction motors having a speed range of approximately 20 per cent.

Booster Pumps for High-Pressure Plants

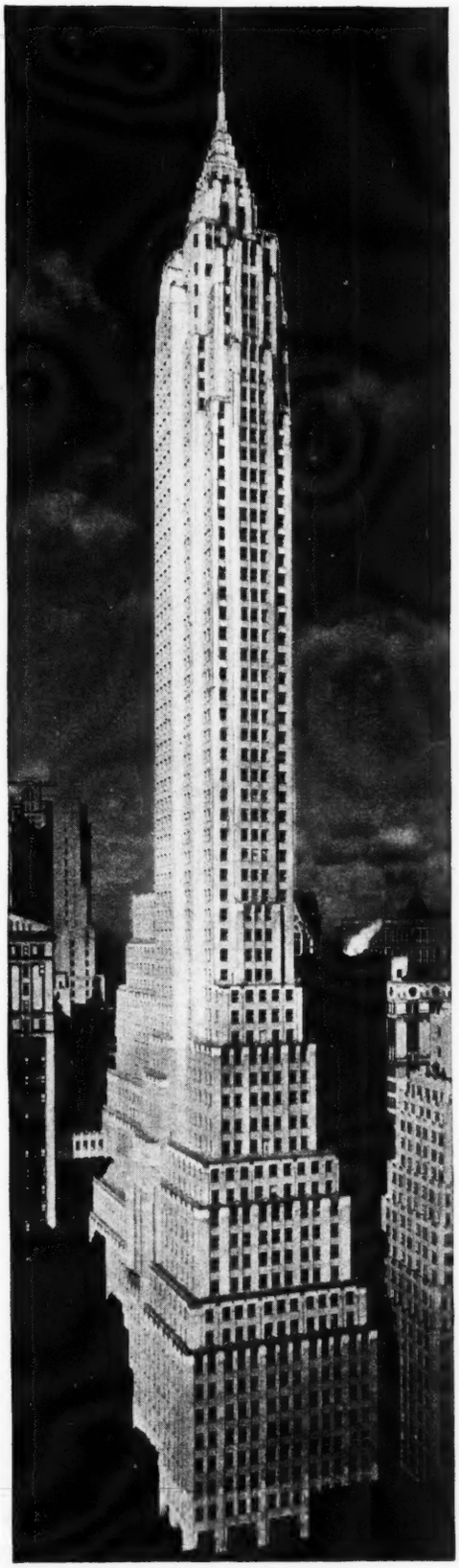
For steam pressures up to 650 lb., the feedwater passes through only the condensate pump and the boiler-feed pump on its way from the condenser to the boiler. For an operating pressure of 1,200 lb. per sq.in., there is usually one and in some cases two booster pumps installed in series between the condensate pumps and the boiler-feed pumps. A recent development of interest is the use of motor-driven boiler-feed pumps of the plunger type to serve the two new 1,200-lb.-pressure turbines in the State Line Station.

▼ ▼ ▼

German Tube Recommendations

The German Boiler Committee has recently published "Recommendations for Water Tubes and Stay Tubes," copies of which are on file in the office of the American Standards Association, 29 West 39th St., New York City. Included are specifications for the quality of the seamless steel tubes, with material and test specifications, method of inspection, tolerances on outside diameter and wall thickness, and the several tests to which the finished tubes should be subjected.

HEATING A SKYSCRAPER WITH HOT WATER



By WALTER TUSCH
Tenney & Ohmes, Inc.

The use of hot water for heating the Cities Service Building is believed to be the first application of this method of heating to a skyscraper. Ease of control and low installation cost are advantages claimed

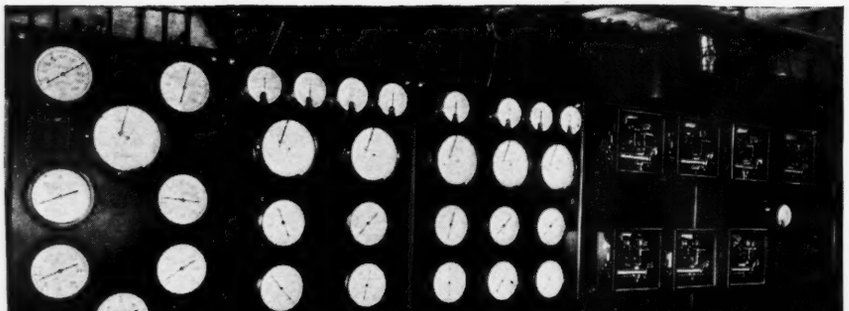
THE 67-story No. 60 Wall Tower recently completed for Henry L. Doherty & Company, at Pine, Pearl and Cedar Streets, in New York City, contains many innovations—notably, the use of hot water as a heating medium. The owners have attempted throughout to obtain a building well in advance of the times, and it was by their direction that the bold step of heating by water was taken.

Steam is, of course, most commonly used for office buildings, particularly for the larger ones. This building is very nearly a record breaker, with gross contents of about 13,000,000 cu.ft., and built on a plot about 125 ft. by 250 ft., the tip of the flagpole on the tower being some 950 ft. above the first floor.

While hot water heat has frequently been used for large and extended institutions supplied from a central hot water heating and pumping plant, and some examples of 10- or 12-story buildings thus heated exist, its use in a building of this character has not previously been attempted. The disadvantages of this form of heat for a tall building are, of course, the high pressures developed in the lower sections of the systems because of static head of water, and the hazard of freezing should windows be left open in severe weather. The chief advantages of water heat from the owner's point of view are economy of operation when the system is properly regulated and economy of installation when it is properly designed.

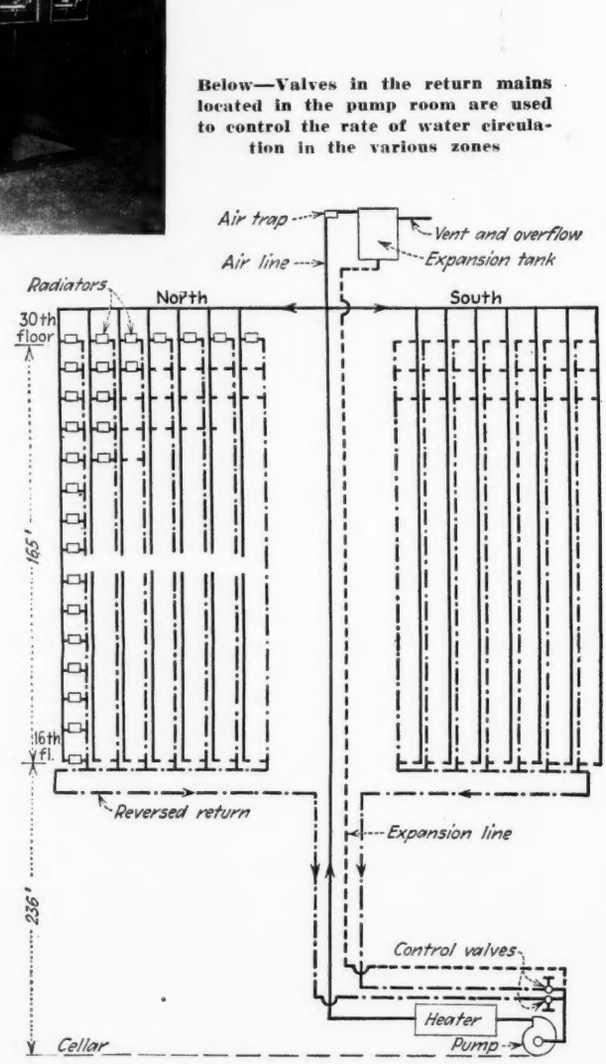
The general freedom from overheating, which avoids the necessity of frequent manipulation of the windows and heating apparatus, together with the mild form of heat, will be a renting factor.

The highest heating surface in this building, a fan blast stack for heating the special officers' quarters on the 63rd to 66th floors, is about 770 ft. above the cellar. There is thus produced a static pressure of some 330 lb. per sq.in. at the pumps. Piping materials and other



Left—An extensive installation of indicating and recording instruments provides the engineer with information concerning the temperature conditions throughout the building and heating system

Below—Valves in the return mains located in the pump room are used to control the rate of water circulation in the various zones



apparatus are available well capable of withstanding such pressures. It was deemed advisable, however, to minimize the pressure on the lower radiators, as well as to provide for greater flexibility of control. This was accomplished by dividing the hot water system into five zones, each not more than fifteen stories high. Fig. 2 is a schematic diagram illustrating the principal features of the *B* zone, which takes care of the 16th to 30th floors. The other hot water zones are similar.

The horizontal runs of the flow and return mains on the upper floors are located above hung ceilings, paralleling structural features, so that it was not necessary to increase story heights for their accommodation. With a steam installation in a tower building, it is usually necessary to provide pipe galleries at considerable expense, thus reducing the rentable space for a given height on account of the necessity of grading and draining long runs of steam pipes.

Two-pipe Downfeed System With "Reversed" Return Mains

It will be noted that the apparatus was designed as a two-pipe, downfeed system. The return mains are "reversed," or so run that the individual return risers connect in an order opposite to that in which the corresponding supply risers are taken from the main supply main. This arrangement produces an equal pressure differential, other conditions being constant, over each riser, thus avoiding uncertainties as to even distribution of the water.

Low-pressure steam was used for heating of the entrances and the first floor only, as being more responsive to the erratic demands at these points, the radiators being of the usual cast-iron construction. All radiators on floors above the first are constructed of seamless copper tubing with extended surface in the form of helical fins, and small cast-iron headers, all concealed in steel cabinet construction. The maximum pressure to which any of these radiators is subjected is about 115 lb. per sq.in. All water piping is of seamless steel tubing with welded joints wherever practicable and forged steel fittings here fittings are necessary.

All hot water heaters and pumps are located in the cellar for convenience of control. Each heating zone is provided with a turbine-driven water-circulating pump and a steam-heated hot-water heater. Pumps for the *A* and *B* zones each have a capacity of 1,400 gal. per minute; for *C* and *D* zones, 400 gal. each; and for *E* zone, 105 gal. per minute. Zones *A* and *B* have a standby heater and direct-connected motor-driven centrifugal pump, so connected as to be available for use on either system if necessary. Zones *C* and *D* are similarly equipped. Zone *E*, much smaller than the others, is equipped with two heaters and two pumps. The calculated hot water load requirements for zero weather and 30-deg. water temperature differences are about 3,600 gal. per minute, or 1,800,000 lb. per hour.

All pumps have cast-steel casings to withstand the high static head and are designed for 60-ft. head, as each zone constitutes a balanced system and its pump operates only against a head equivalent to the friction in the distributing piping. The exhaust steam from the turbine of each zone is delivered to the low-pressure steam header for the hot-water heaters. As the steam demand of the heaters is greater than the amount of turbine exhaust available at all times when heat is re-

quired, all the exhaust will be utilized for water heating. Indeed, even at the high water rate resulting from a back pressure of 10 lb., this exhaust will, in average weather, supply less than half of the total steam required, the remainder being made up by live steam through reducing valves.

Steam is furnished by the New York Steam Corp. from its main in Cedar Street at about 130 lb. pressure, through an 8-in. service connection. Three meters are provided, two 6-in. for winter requirements and one 4-in. for the summer domestic hot water supply load. The pressure is reduced in two stages with separate reducing valves for the hot-water converters, the domestic hot-water heaters, the first floor and entrance heating, and the heating stacks of the central ventilating systems. The return water of condensation passes through economizers, preheating the supply to the domestic hot-water heaters en route to the sewer.

Rate of Water Flow Can Be Regulated

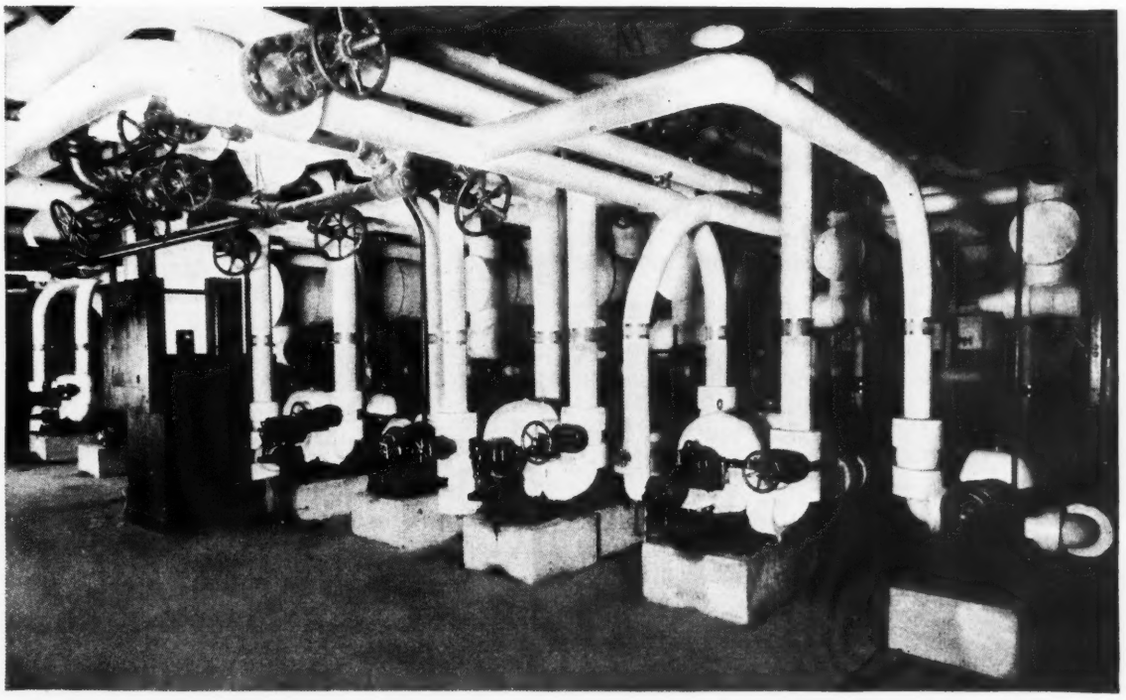
The zoning of the building vertically, into the steam zone for the first floor and the five hot water zones for the upper floors, will enable the operators to regulate the rate or time of water flow, as well as the temperatures, to meet the requirements of these different parts of the building. In addition to the vertical zoning, the steam zone is divided into separately valved mains for the northerly and southerly sections, as are the four lower hot water zones. Of the hot water zones, the two lower, which serve the greater bulk of the building located below the greatest building set-back, are provided with separate valves located in the pump room on the return mains for the northerly and southerly sides of the building. It will thus be seen that the hot-water heating system is divided into nine major sections, all of which can be regulated by valves in the return mains by the attendant without leaving the pump room. To make this possible, distant reading temperature indicating devices are located on the gage board so that he may be informed of the actual temperature of selected points on any floor.

Maximum Economy Possible

With all these provisions, it will be appreciated that the maximum economy resulting from intelligent and systematic control of the heating medium will be obtained. This close regulation also will result in better satisfied tenants who will be thus spared the too common overheating or lack of heat due to uncompensated wind, sun, or updraft condition.

The zoning of the systems had also the result of reducing individual risers supplying the radiators to a size readily taken care of in the furring spaces available. The average size of these risers is $2\frac{1}{2}$ in., and none exceed 3 in. The main riser for Zone *A* is 8 in. in diameter, and it is interesting to note that a low-pressure steam riser of similar heat-carrying capacity, about 20,000,000 B.t.u., would probably have been made at least 14 in., if installed in accordance with usual practice.

Clinton & Russel were the architects, and Tenney & Ohmes, Inc., the consulting engineers. The installation was supervised by G. W. Saathoff, chief engineer, Henry L. Doherty & Co., and Victor H. Mueller, chief designing engineer.



In back of the pumps which circulate hot water through the heating system may be seen the water heaters

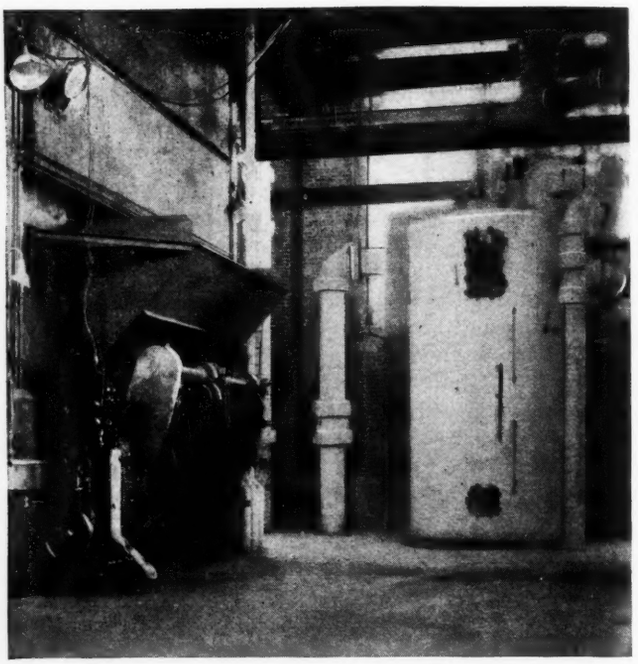
▼ ▼ ▼

Pilgrim State Hospital Plant Provides

Steam Electricity Water

Refrigeration

Actually a small-sized city, this hospital requires a 3,400-kw. power house which also provides hot and cold water and steam for heating, laundering and cooking



The domestic water heater is located on the boiler room floor

NEAR Brentwood, L. I., New York State has under construction what is believed to be largest institution for the care of those suffering from mental disease. The buildings of this project were planned to accommodate approximately 9,000, including patients, doctors, nurses and other employees. Four groups of hospital buildings were planned to house the more or less permanent or incurable patients. Each group, with accommodations for approximately 1,500 patients, comprises four wards and a central dining room and kitchen building. Construction of all of these buildings is well under way, and several are furnished and occupied. Another group upon which construction has not yet started comprises general reception, medical and surgical buildings.

An institution of this size constitutes a small-sized city requiring services such as light, water, sewage disposal, bakery, laundry and refrigeration. These services are furnished by a group of buildings south of the hospital and include a power house of 3,400-kw. capacity, which in addition to supplying power furnishes hot and cold water and steam for heating.

The New York State Division of Architecture has for a number of years received and filed daily operating logs from the power plants serving the various state institutions. These logs contain such information as the daily consumption of hot and cold water, steam produced, kilowatt hours generated and coal consumed. Although such data cannot be used on a per patient basis to estimate accurately the requirements of a new institution because the service facilities of the various institutions differ materially, nevertheless such information served as a valuable guide to the engineers in determining the capacities of the equipment installed in the power house.

An estimate of the building heating requirements indicated that about 496,000 sq.ft. of equivalent radiation would be installed. This figure was made up partly from actual design data on those buildings for which plans were complete and partly from estimates based on cubical content of proposed buildings. Assuming 0.25 lb. of steam per sq.ft. of radiation per hour, the maximum steam required for heating would be 124,000 lb. per hour. Based on the laundry requirements of other similar institutions, it was estimated that the laundry demand for steam would be about 10,000 lb. per hr.

The hot-water requirements of institutions of this nature are greater than in other types of hospitals because of the large amount of water at blood temperature used for continuous hot water baths in treating certain types of patients. In other similar institutions hot-water requirements average between 400 and 500 lb. per patient per day. To heat this water for an occupancy of 9,000 would require about 17,000 lb. of steam an hour and a possible peak of 33,000 lb. an hour.

Steam required for cooking was more difficult to estimate in this case, since it was planned that part of the cooking would be done by electricity, the first time this load had been encountered. However, a peak allowance of 10,000 lb. an hour was made for this purpose.

Summation of these requirements gives a peak demand of 177,000 lb. per hr. To supply this load four boilers, each of 10,000 sq.ft. heating surface, were installed. Allowing one unit down for repairs, three boilers operating at 200 per cent rating would deliver about 198,000 lb. of steam an hour. This is 20,000 lb. per hr. over the estimated peak, giving a liberal allowance for steam required for feed-water heating.

The peak demand for power was estimated at 2,000 kw. with an average load of between 900 and 1,000 kw.

It is evident that during winter peak steam requirements, the peak power load can be generated as a by-product of the low-pressure steam required for building and water heating even though the initial steam pressure is relatively low. With dry saturated steam at 150-lb. pressure, an engine can be expected to generate a kilowatt on about 38 lb. of steam when exhausting against a back pressure of 5 lb. Thus the peak demand of 124,000 lb. per hour for building heating, plus 33,000 lb. for domestic water heating and 20,000 lb. for feed water heating or 177,000 lb. per hour total, would generate 4,600 kw., whereas only a 2,000-kw. peak was estimated.

On a mild day of say 50 deg. temperature, the heating requirements would reduce to about 35,000 lb. per hour. Steam requirements for heating domestic water would remain the same at say an average of 17,000 lb. an hour. Allowing 6,000 lb. for feed-water heating, there would be required an average of 58,000 lb. of low-pressure steam an hour. This amount of steam would generate 58,000 ÷ 38 or 1,530 kw., which is more than the estimated average kilowatt demand.

From these estimates it was apparent that the average power requirements could be generated as a byproduct of the heating steam during all of the winter and most of the spring and fall. Even during the summer when no steam for building heating is required only about 50 per cent of the exhaust would be discharged to the atmosphere. Steam for laundry and kitchen has not been included, as it is used at higher pressures than the engine exhaust.

Under these load conditions, experience with other institutions had indicated that power could be generated for less than a cent a kilowatt and that the operation of a power plant was highly economical.

The generating plant installed contains three engine-generator sets, two of which are of 1,500-kva. capacity and one of 781-kva. Space for a third 1,500-kva. unit has been provided in the engine room, which is only one foot above grade level. The two larger units each consist of two four-valve engines directly connected to a single generator and flywheel. The engine driving the 781-kva. generator is identical with the dual engines driving the 1,500-kva. generator units. All engines have 29-in. cylinders, 36-in. stroke and operate at 133 r.p.m.

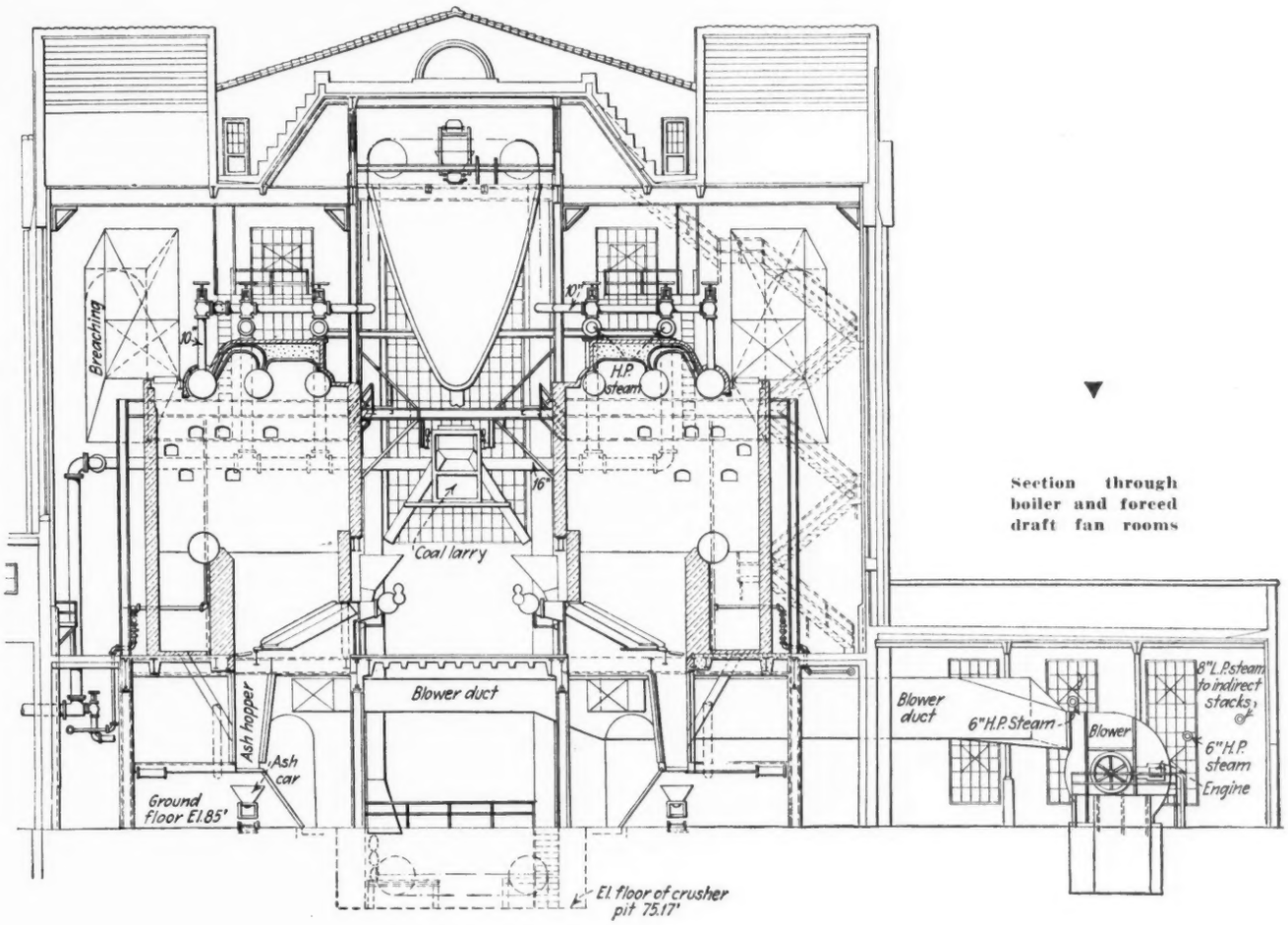
To avoid the large eccentrics made necessary by the large shaft diameter required by the dual units, and which would be somewhat unwieldly for flywheel governor control, a new oil-relay valve-gear mechanism was developed and used on these units.

A lay shaft driven through worm gears by the engine shaft operates the valve mechanism and a flyball governor. Movement of the governor arm operates an oil-relay pilot valve. The power cylinder of the oil relay operates a linkage which controls the cutoff of both engines. The 781-kva. unit has a similar governor.

Current is generated at 2,300 volts and distributed from a switchboard in the engine room to the institution buildings where transformers reduce the voltage to that required.

The engines exhaust to two 30-in. exhaust headers centrally located under the floor of the engine room, which in turn discharge through large 48-in. oil separators in the pit between engine room and boiler house.

Returns from the heating systems and other institu-



Section through boiler and forced draft fan rooms

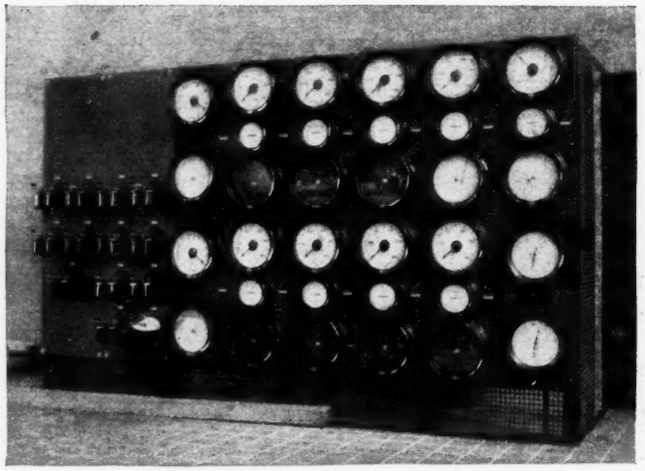
tion uses are pumped back to the power house by vacuum pumps located in certain of the buildings. Drips from the steam piping are returned by vacuum pumps located in the laundry. These returns are collected in two large tanks located in the pump pit. Two steam-driven pumps 10x14x12-in., deliver these returns to the feed water heater in the boiler room. Two make-up water connections under float control also deliver water in the feed-water heater. From the heater the water flows by gravity to two 520-g.p.m. turbine-driven feed pumps, which deliver feed water at 210 deg. through two 6-in. mains to the boilers. The feed pumps are located in a room in the basement of the boiler house, together with three hot-water circulating pumps which receive water from the domestic hot-water heaters in the boiler room and circulate it to the institution. Hot-water circulation return mains discharge back to the heaters.

The open feed-water heaters are of the metering deaerating type designed to heat 240,000 lb. of water an hour. A vent condenser is provided with storage capacity for about 39,000 lb. of water. For domestic hot water, two duplicate closed heaters are provided, each capable of heating 50,000 gal. of water an hour from 50 to 160 deg. The two heaters are served by a single deaerator vent condenser and storage compartment of 4,000 gal. capacity, but the steam-jet air-removal equipment is provided in duplicate. A flow meter is also provided in this heater. The laundry water heater in the pump pit receives water from the domestic water heaters and raises its temperature to about 200 deg. It has capacity to heat 10,000 gal. per hour.

Coal for the plant is delivered by railroad and discharged from a trestle either to storage or into a track bunker. From the track bunker an apron conveyor delivers it through a crusher, which discharges to a bucket elevator. The bucket elevator delivers to a horizontal scraper conveyor, which distributes the coal to a 400-tor steel bunker located between the two rows of boilers The coal-handling equipment is designed to handle 60 tons an hour. From the steel bunker the coal is delivered by weigh larry to the stoker hoppers.

Four bent-tube four-drum boilers, each containing 10,000 sq.ft. of heating surface, have been installed to deliver dry steam at 150 lb. pressure. The boiler house was laid out for six boilers, but the two middle boilers have not as yet been put in.

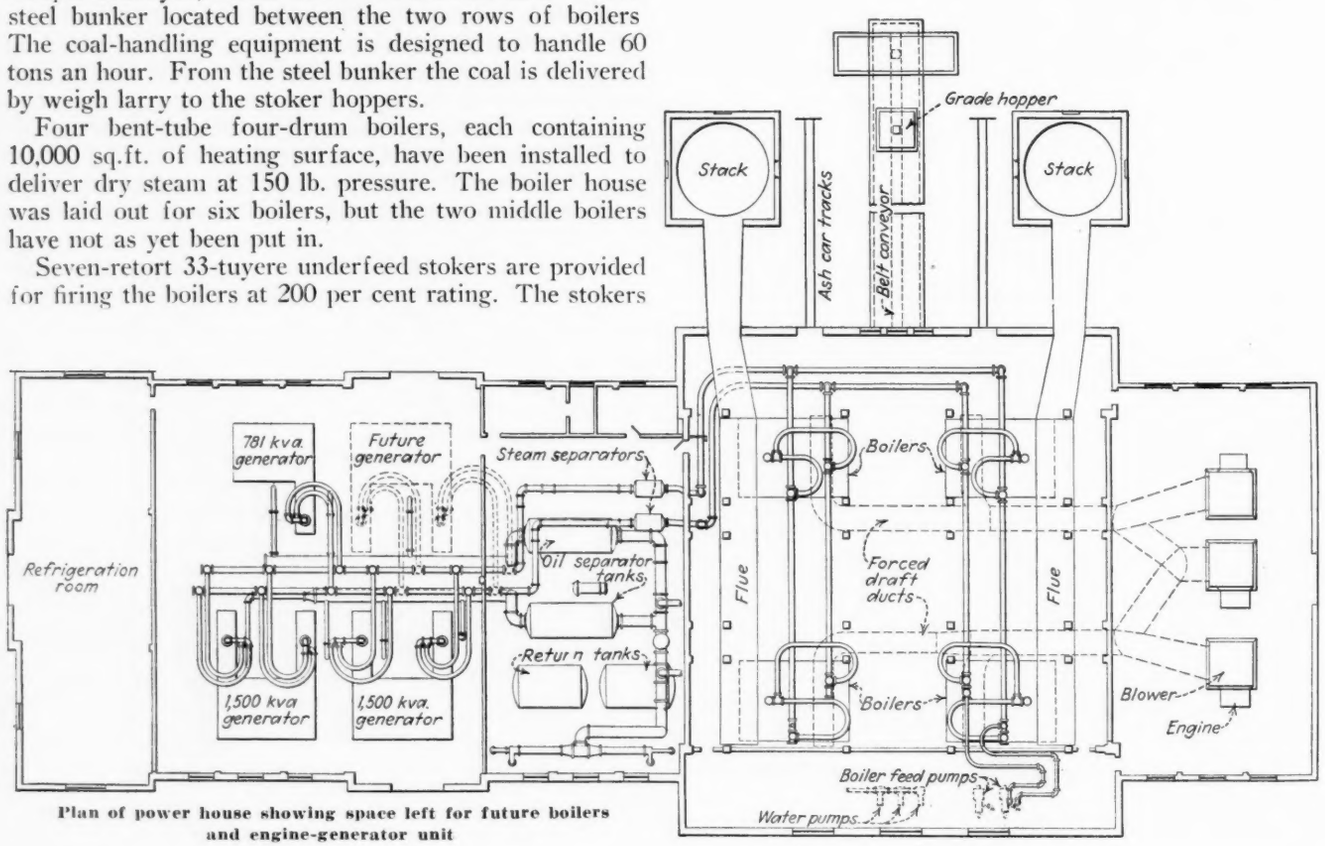
Seven-retort 33-tuyere underfeed stokers are provided for firing the boilers at 200 per cent rating. The stokers



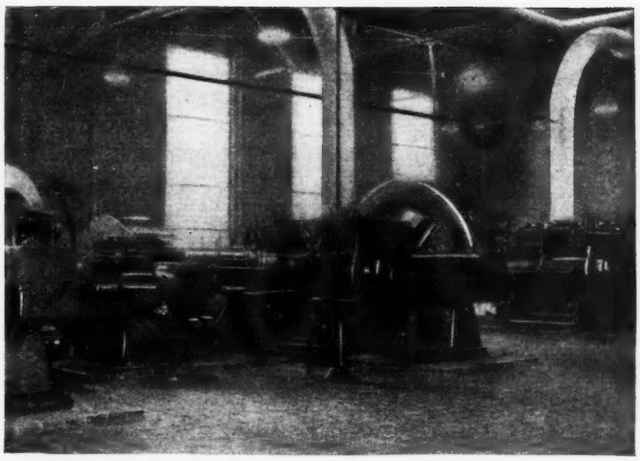
Control and meter panels for the deep well pumps

are driven by vertical steam engines and are provided with steam-operated ash dumps. The ashes are at present dumped into narrow-gage cars and wheeled out from under the boilers for disposal to trucks.

First-quality fire brick is used in the boiler settings to a depth of 9 in. and second-grade for the rest of the walls, which are 22½ in. thick, except for the bridge wall and the side and front walls which are faced with air-cooled Carborundum brick. At about the level of the mud drum the setting is divided horizontally, the upper front and side walls being supported on beams. The lower portion of the setting overlaps inside the upper portion and is supported on beams at the boiler room floor level. This arrangement permits independent expansion of the upper and lower parts of the setting and also allows renewal of the lower portion, where greatest



Plan of power house showing space left for future boilers and engine-generator unit



Two 4-valve engines direct connected to a single 1,350-kw. generator

maintenance is normally required, without disturbing the upper portion of the setting.

Three engine-driven forced-draft fans are arranged in the boiler-house basement, so that one fan normally supplies two boilers and the third fan acts as a spare. The 146-hp. engines driving the fans, which are of 90,000-c.f.m. capacity, are of the four-valve type.

Steam from each boiler may be delivered to either of two 16-in. headers which are supported above each row of boilers. These four headers discharge to the two main steam lines supplying the engine room. This piping arrangement is extremely flexible.

Adjoining the engine room is a refrigerating plant containing two 50-ton and one 30-ton ammonia compressors. These units supply refrigeration for cooling storage rooms and for making ice used by the institution.

Water for the institution and for the power house is obtained from eight wells, the most distant being two miles from the plant, while the nearest is one mile. At each well is a 400-g.p.m. deep-well pump which is controlled at the power house from a panel board located in the engine room and also from the pump house. The board in the power house contains indicating, recording and integrating flow meters, and an indicator showing the level in the reservoir to which the pumps discharge. This reservoir has a capacity of 1,500,000 gal. Five motor-driven pumps located in a pit between the engine room and boiler house draw water from the reservoir and pump it to a standpipe on the north side of the institution. Two of the pumps have a capacity of 750 g.p.m., two of 1,000 g.p.m., and one of 1,500 g.p.m., the latter serving also as a fire pump. These pumps are arranged to start automatically as the standpipe pressure drops, cutting in at intervals of 25 pressure.

▼ ▼ ▼

THE NEW "POWER"

WITH the July number of *Power*, a new publishing plan will be inaugurated.

EACH number of *Power*, as a monthly, will contain a very much wider variety or range of subject matter than ever before. A new contents page, conveniently indexed, will be placed in front of the editorial pages. The treatment of the new *Power* will make every page of maximum interest.

THE CENTER of the book will contain an eight-page feature, with four editorial pages specially printed in color, with pictures, feature articles and data sheets of unusual reference value.

POWER will, of course, continue the features and departments which have characterized it these many years. Its subject matter will be chosen so that each number will become a permanent book of reference, suitable for binding if you wish.

IN CLIMAX, *Power* will publish one additional special convention number each year at such time as may be required to provide timely and up-to-minute Power Show or other convention news of maximum importance to the *Power* reader.

THE JULY number will include:

THE STORY of a department store which finds its power plant one of its most profitable investments, foot for foot of occupied space. Steam, diesel, electricity, all play their part.

A CLEAR-CUT story on oil fuel which should find favor and real usefulness where people are burning fuel oil or contemplate doing so.

SOME real ideas for plant engineers on charging power services to factory departments.

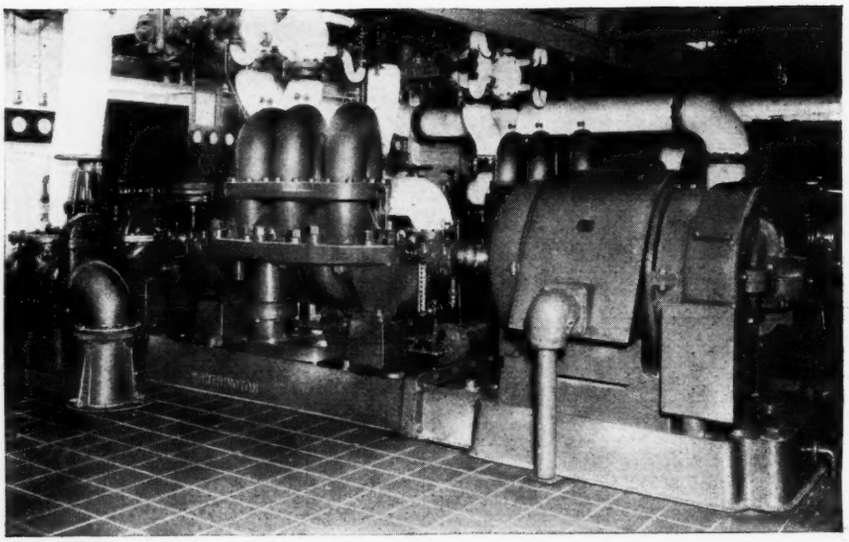
OPERATING results of an installation which heats buildings with refrigerating equipment, showing what opportunities there are in this modern system.

A WIDE range of additional articles embracing electricity, boilers, combustion, piping, hydro and other power subjects.

FINALLY, the departments, such as Practical Aids to Operation, What's New in Plant Equipment, Current Comment and Happenings in the Power Field—all of these will be generously treated for maximum usefulness to the reader.

THE editors are sure you will be pleased with the new *Power*.

All wiring is brought to this pump motor in rigid conduit connected to the motor frame



POWER SYSTEMS PLANNED FOR MAXIMUM SERVICE

A power system is no more reliable than the feeders that connect the generating plant to the motors and other power-consuming devices. Seven factors are given that should govern the design and installation of a power system to make it reliable and safe to operate

By MARIN PHILLIPS
Niagara Falls, N. Y.

A GREAT deal of thought and engineering is back of every power generating station in order to make it efficient and reliable in operation, but when completed its efficiency and reliability may be defeated by inefficient and unreliable power lines. Because some elements of the power system are neglected when it is planned, trouble and delays are caused after the equipment goes into service. Ideal electrical installations are not produced by chance. One cannot expect continuity of operation and low operating cost when the equipment is installed in a haphazard manner. When planning an electrical installation several factors must be kept in mind and given careful attention, such as:

1. The installation must be made as safe and accessible as possible for the operators and maintenance men.

2. Cost should be kept as low as is consistent with reliability and safe installation.

3. Consideration must be given to the location of the equipment and driven machinery in order to select the most economical centers of distribution.

4. The number of main feeders that should be run must be calculated.

5. Over-capacity to be provided in the main feeders will be determined by the number of motors and other equipment to be supplied from the feeders in the future.

6. The method of installing the wiring should be considered.

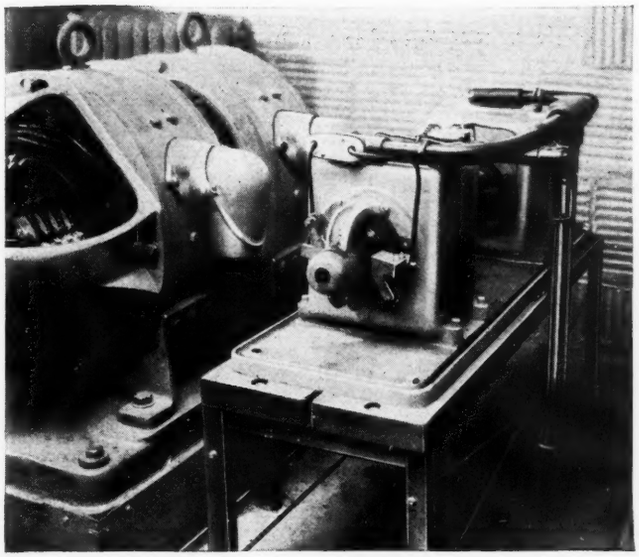
7. The electrical equipment must be located so that it will not be in the way of other machinery and yet will be accessible for operation and repairs.

There must be a minimum of live parts exposed if the installation is to be safe electrically for the operator. It must also be as accessible as possible to be safe for the repairman when he changes fuses or makes repairs. This can only be accomplished by eliminating ladder climbing and the necessity for working in cramped quarters, exposed to piping and other grounded objects. Most burns and other accidents suffered by electrical workers are traceable to conditions under which they are working. Plant management is striving today to reduce accidents to workers and is spending large sums on accident prevention. Properly installed electrical equipment to improve working conditions is an important contribution to plant safety.

Where low cost is made paramount to other considerations when an electrical installation is planned, the cheapest installation may be adopted. Such an installation will generally prove to be the most expensive, due to equipment failures with their resultant delays, high maintenance cost and accidents to workmen.

A great deal of forethought and study is required in order to select the most economical centers of distribution. In order to plan and lay them out to the best advantage, consideration must be given to determine if future installations of machinery make it necessary to remove the distribution center. Also, is it cheaper to run the main feeders near the motor settings and to run short lines to them or to end the feeders further away and to have longer small lines running to the motors?

These questions can be answered satisfactorily only by figuring the cost of conduit, wire, labor, etc., for the small lines and comparing it with the cost of the large one.



On the small motor generator, conduit and fittings are applied to obtain a reliable wiring job

The number of feeders to run will depend largely on the contemplated installation and the grouping of the machines. If it is decided to keep each motor independent, a main feeder will be required for the individual motors on each machine. This applies, of course only to machines having motors that provide a load for a single feeder. It is usually the practice to supply several motors of small capacity with one feeder.

The over-capacity to allow in each feeder will depend on how much future motor horsepower is likely to be installed or whether the motors will be changed to larger sizes later. It has been my experience that it pays to install all main feeders with a 25 to 50 per cent overcapacity to take care of future installations. When the centers of distribution have been decided upon and the total load to be supplied determined, the size of the main feeder lines can be calculated. Over capacity in feeders is not as costly as it may seem, and will be balanced by reduced power losses in the cables, longer insulation life due to absence of excess heating and a higher terminal voltage at the motors, which will reduce their heating and increase production.

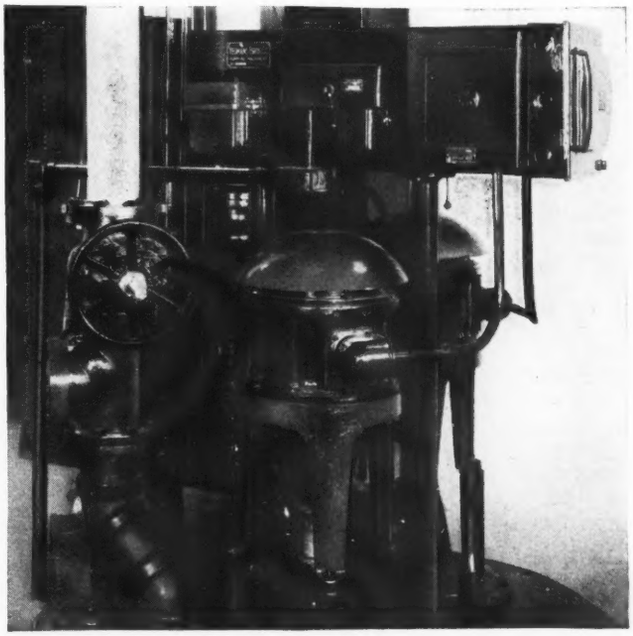
The main feeders may be run in conduit, overhead, underground or parkway cable. The last three methods will apply to outside wiring, such as that between buildings. From the standpoint of reliability and safety to workmen and neatness in appearance, conduit has many points in its favor. All small wiring should be run in conduit, and when properly installed it will require little maintenance. Also, there will be less danger of equipment delays due to damaged wiring. But when large main feeder lines are to be run, say in sizes above 500,000 cir.mils, they can in many cases be run in the open, placed well up out of the way. This type of installation will save the cost of large conduit and will often make a more reliable installation than if the conductors were pulled into conduit, especially if extreme care is not used in its installation.

The advantages of overhead lines are low first cost, relatively high overload capacity, and ease of making taps or splices. The disadvantages are unsightly appearance, relatively high maintenance cost, obstruction to fire-fighting equipment, yard cranes and building operations, and possible danger from lightning and storms.

Underground lines offer the advantages of low maintenance cost, permanency, and protection from lightning as well as being out of the way. Their disadvantages are higher first cost and reduced overload capacity in comparison with the overhead line. In many cases the extra cost for the underground duct system will be justified. When planning the underground duct system of distribution extra ducts should be installed to take care of future load requirements.

A permanent and cheaper underground distribution system can be installed by the use of parkway cables, although it will be less reliable.

The main feeders will terminate at the distribution centers. From this point the distribution of power will be made to the individual motors by one of two general methods. The first is by running a sub-main feeder through the motor location and tapping off at the most convenient point for each individual motor. With the second method safety switches or oil switches are mounted on a panel frame work and an individual line is run to the starting equipment for each motor. All taps for the line switches will then be made in a common junction box. The first method will be satisfactory and the most economical for a small motor layout, but the second method will be more desirable where large motors are involved, due to the difficulty of making reliable splices with large wire in junction boxes.



All wiring to the starting equipment and to the motors is entirely inclosed in rigid conduit

A late development in power distribution consists of a sectional overhead duct system designed more or less to fit the particular installation. Conduit knockouts are provided for convenience in taking off taps at the most desirable locations. This system is also available in the form of an overhead bus. The necessary turns and fittings are provided to build a complete conductor system to cover a given area. Frequent openings are provided for making motor taps. The overhead duct and bus layout is not adaptable for universal use. However, it can be used to advantage in a great many cases.

READERS' PROBLEMS

ELEVATOR RUNS AT OVERSPEED—*One of our passenger elevators, which is of the direct-current, geared, drum type, at times develops a tendency to race. The machine may operate normally for a day or more, then start to run at a greatly increased speed. When the car is stopped and started again, operation is normal. What might be the cause of this periodic over-speeding?* M.E.W.

Overspeeding of an elevator driven by a direct-current motor is in most cases caused by weakening of the motor's field. This effect can be produced in several ways: first, it may be caused by a poor connection in the shunt-field circuit, such as a defect in one of the field coils, a bad splice, a contact that is not making properly or a loose connection. When looking for the trouble, thoroughly investigate all parts of the shunt-field circuit for defects. If a voltmeter is available, connect it across one of the shunt-field coils to determine if the voltage remains fairly constant, as it should.

A second source of the trouble is the series field winding, which should be cut out of the circuit when the motor comes up to speed. If the car is lowering a heavy load, or is running with only the operator in the up direction and the series winding is in circuit, the elevator may overspeed. This is caused by the series-field amperic turns opposing the effects of the shunt winding when the motor is overhauled and becomes a generator. If the series winding were connected to oppose the shunt and remained in circuit during motor operation the motor would tend to race when lifting a load.

To test for this condition, open the shunt-field circuit and start the motor on the series winding. The motor should turn in the same direction as when the shunt winding was connected, if both field windings have correct polarity. Cases are on record where the series winding was cut out in two sections and one section was connected right and the other wrong. Conditions developed in the control where the section connected to give correct polarity was cut out after the motor started and the field section having wrong polarity was left in circuit. The result was that with certain loads in the car the motor would race.

CORLISS ENGINE WITH CONDENSER—*During the winter we utilize the exhaust from our Corliss engine in the heating system at a 5-lb. back pressure. A condenser was installed so that the engine can be operated condensing during the summer when steam for heating is not required. The engine does not seem to run as smoothly as formerly. What is the trouble?* R.L.D.

When changing from non-condensing to condensing operation the valve setting of the engine should be changed so that the exhaust valve will close earlier as more compression of the low-pressure exhaust is required to obtain the same cushioning effect of the piston. If you have not made this change it probably explains the poorer operation. With a double-eccentric Corliss valve gear more compression is obtained by setting the exhaust eccentric forward. The valve setting should be determined from indicator diagrams, but, in any case, there should be no more compression than necessary to insure smooth running of the engine.

▼ ▼ ▼

Many Oppose Straight Heat Basis of Charging for Process Steam

Two of the readers' answers to question published May 24 fix dollar value of process steam at its value for power generation

OUR POWER is furnished by a condensing turbine bleeding to process at 5 lb. pressure. Throttle steam and bled steam are metered. High-pressure steam costs are figured monthly. To reduce consumption it is proposed to charge manufacturing departments monthly for their actual use of power and bled steam (and, of course, high-pressure steam also). The most reasonable suggestion, apparently, is the following: Without attempting any elaborate thermal computations, bill bled steam at the month's unit cost of live steam minus an arbitrarily fixed 5 or 10 per cent. Credit the steam so sold to the turbine to get the net cost of electricity.

One possible objection to this plan is that it will cause the cost of electricity to vary greatly from month to month. Will we not get complaints from the production departments in months when the unit cost of electricity goes way up because less is made as a byproduct? Would it pay to avoid this difficulty by setting up the power plant as a separate "business," furnishing steam and electricity at fixed rates designed to leave a little profit at the end of a year's operation, but not necessarily to make money in any given month? I would be glad to get practical suggestions from POWER *readers in this connection.* G.E.A.

Figure Steam as Byproduct and Charge a Profit

UNDOUBTEDLY the most satisfactory method of handling this problem would be to set up the power plant as a separate producing department. In this way the actual cost of steam and power could be determined. Then the various departments could be charged for their actual power and steam consumption according to the meter readings.

On account of the difference in the cost of a kilowatt during the summer, when the waste heat from the turbines cannot be used, and the winter when it generally can be used 100 per cent through the heating system, it is best to establish the electric power cost on the average for the entire year.

Since the heating expense for the various departments is generally a considerable item, someone may raise the usual question of whether the power or the heat shall be considered the byproduct. The various departmental foremen will probably be clamoring for the heat to be figured as the byproduct and sold low. However, since it is imperative that the heating system be operated during the winter whether the generator runs or not, it is no more than fair to consider the power as the byproduct and charge for the heat used by the plant at full value. The fact that this reduces the cost of a kilowatt to a very satisfactory figure is also just because that is the reason the management put in a power plant instead of a simple heating installation with perhaps a couple of high-pressure process steam boilers.

Both heat and power should be sold to the shop at a profit which is enough to enable the power plant to set up a fund to protect it in case of a breakdown repair job and also to permit the purchase of more modern equipment as it is developed. A wide-awake engineer will keep the power plant up to top notch if he can get the proper equipment to do it with. GEO. P. PEARCE.

Moline, Illinois.

Charge Steam at Its Power Generating Value

G.E.A.'s question is easily answered if the fundamental principles of charging for steam and power are understood. If steam is used in a prime mover a certain amount of heat is available for conversion to power, depending upon the initial pressure and temperature of the steam at the throttle and upon the average condenser pressure. This amount of heat is all that is available for the production of power, and the user of process steam at less than throttle pressure should be charged in proportion to the amount of heat remaining, which would have been available for power if used in a prime mover.

An example will show how this can be worked out. Assume: throttle pressure of 350 lb. gage, throttle temperature of 700 deg. F. and condenser vacuum of 29 in. Steam is to be bled at 150 lb. gage and 5 lb. gage. Starting at 350 lb. gage and 700 deg. F. on a Mollier diagram, spot in 150 lb. gage, 5 lb. gage and 29 in. vacuum on the constant entropy line and read the total heat at these points as follows:

350 Lb.	700 Deg.	1,364	B.t.u./Lb.
150 Lb.		1,276	"
5 Lb.		1,100	"
29 In. Vac.		887	"

The total heat drop available for power is, 1,364 — 887 = 477 B.t.u. per lb., and the value of bled steam will then be: at 150 lb., $\frac{1,276 - 877}{477} = \frac{399}{477} =$ 0,836, say 85 per cent and at 5 lb., $\frac{1,100 - 877}{477} = \frac{223}{477} = 0.468$, say 50 per cent.

When bled steam is charged by this method, the amount bled will not effect the cost of power. N. D. GRISWOLD.

Midland, Mich.

Figure Daily Consumption

THE ENGINEER at the plant in question is trying to reduce the cost of operation by getting the various department heads interested in the steam and electric energy they use. The problem then is how best to make these charges.

The power plant should be considered as a manufacturing unit. The finished product is steam and electrical energy. With steam and electric meters on the lines going to the various departments, the amounts used are readily determined.

Relative to the steam consumptions, these figures can readily be reduced to a "from and at 212" basis, thus placing the relative consumption of all departments on a common basis. This also can easily be connected with the efficiency figures computed in the boiler house. Where some departments have return condensate going to the boiler house some credit should be allowed.

With the above figures on a "from and at 212" basis a percentage can be worked up for the total steam distributed from the boiler house and the bled steam from the turbine room. The electric department can then be charged with the difference of steam to the turbine room and that distributed to various departments.

Since the power department is a nonprofit making department, the proper percentage charges can be readily made at the end of each month. Since, due to the amount generated each month, the cost varies considerably, the actual amount of steam used when billing departments can easily be shown. This figure then can be used to compute the amount of steam or the kilowatt-hour consumption per unit of finished product.

Even though the cost will vary per 1,000 lb. of steam or per kilowatt hour, the cost figures so arrived at will give a better check on manufacturing costs than will a method of setting up an arbitrary figure and making allowances at the end of the year.

I have always used the daily check system. When the meters are read each morning the consumptions of the various departments are shown on small cards and sent to the department heads. They, having their output figures, are able to keep daily check on unit consumptions. This system also tells one within 24 hours of any serious losses in the distribution system.

Knoxville, Tenn. CARL D. MORGAN.

Another Proponent of Power Generating Value

THE QUESTION propounded by G. E. A. is one which has come up rather frequently in the writer's practice as consulting engineer.

If the low-pressure process steam bled from the turbine is charged to the consuming departments on the basis of its heat content the cost will be so nearly that of live steam that there will be no incentive to its use in preference to live steam. Also, the cost of electricity will be very low. Such a method discriminates against the department using low-pressure process steam and favors others using power only.

A method which is fair is to determine the unit cost on the basis of the value which the bled steam would otherwise have for power generation. By this method an equitable cost is obtained. The consuming department is charged at a unit cost materially lower than the cost of live steam, and the power plant is not penalized because of the need to furnish the bled steam. With the credit allowed for the low-pressure bled steam, the steam cost of the power plant will be practically the same, whether the demand for bled steam is heavy, light, or even nil.

According to this plan the power plant receives some incidental benefits. For one, when more steam is bled more must be generated, so that the unit cost of live steam drops and the cost of power accordingly. Another, if the process use is such that condensate is returned, the power plant gets the benefit of the greater heat content.

A third benefit is that as more steam is bled less is condensed so that the quantity of circulating water needed is less with decreased consumption of power by the circulating pump. These considerations are, however, of minor importance and unless it is desired to carry the allocation to a fine point, need not be considered. B. M. BAXTER.

Middletown, Ohio

Charge By Actual Cost, But Add a Profit

THE WRITER has found it best to charge as nearly as possible to the *actual dollar cost* of power supply in factory costing. This has to be known first, even if a "profit" is added on. Moreover, this profit figure militates against the practical use of the figures by the management.

The business man needs real costs, not empirical figures, from which the "profit" has to be deducted mentally before logical comparisons can be made.

The "five or ten cent" method appears best, but surely this figure can be approximately correct. If a test cannot be run for the actual plant the figure could be checked by reference to the units of heat in the steam (all per pound) at the bled stage, compared with the units in steam as generated and the units of heat in the steam, which is not bled, but which is finally rejected after running through to condensers.

Regarding variation in cost of power or heat to process: If the cost *does* vary (i.e., if cost is higher as the result of smaller process production) it is good to know it and not "howl" about it. The knowledge may point the way to improvement in efficiency.

In the matter of the use of monthly figures by the management, the writer has found a tendency for a definite attitude to develop. The management has a habit of comparing power costs with the dollar sales and to expect the power cost to vary with the output.

Every superintendent engineer knows that this is not practically the case, especially if monthly figures are used without explanation. There may be a repair occurring in one month and properly included by the clerks in the month's figures—making them large—and yet this repair may not be needed again for many months.

In an extreme case of this sort—as in expensive repairs to deep well pumps, not likely to be repaired for years—the writer has found that an experienced accountant will readily agree to put cost of such a repair in a *suspense account* from which the proportional part is charged each half year.

JOHN STEVENSON.

Los Angeles, Calif.

The Method of "Similarity" Applied to Fluid Meters

By E. S. SMITH
Builders Iron Foundry

The "research reference" table published in the May 26, 1931, number of *Power* contained two items of research, the stated results of which are not in agreement with the findings of the Builders Iron Foundry. Because of this and the wide interest in fluid metering throughout the power field, the author is here given the opportunity to present his views on this subject

▼

APPLICATION of the method of similarity to fluid metering is being actively discussed before both the American Society of Mechanical Engineers and the American Society of Civil Engineers, and their Transactions record the general convergence of initially differing viewpoints. The general acceptance in this country of this useful method seems only a matter of time.

All fluids, whether liquid or gaseous, have both density and viscosity; in addition gaseous fluids may expand appreciably in passing through Venturi tubes, nozzles, and orifices. Liquids generally do not have an appreciable change of density in passing through such meters.

It is convenient to use the following hydraulic formula, which assumes that the effects of viscosity and compressibility are negligible:

$$Q = \frac{C\ Y\ A_2\ \sqrt{2gH}}{\sqrt{1-(D_2/D_1)^4}}, \text{ where}$$

Symbol	Quantity
Q	quantity-rate of flow just upstream of center, cu.ft./sec.
A_2	area of reduced section, throat of Venturi tube, sq.ft.
D_2	diameter of reduced section, Venturi throat, ft.
D_1	diameter of pipe section, inlet of Venturi, ft.
g	acceleration of gravity, ($\sqrt{2g} = 8.022$), ft. per sec.^{2}
H	differential head of fluid, ft.
C	hydraulic coefficient (correcting for viscosity). $C =$ 1.000 theoretically for frictionless fluid in an ideally streamlined Venturi tube
Y	net expansion factor, correcting for the expansion of gaseous fluids ($Y = 1.000$ for liquids).

In this formula, the product CY for a gas is determined in practice as follows: C is found by experiment on a convenient liquid (hence is known as hydraulic), then Y is the ratio of the gaseous flow to the liquid flow having the same Reynolds number. This *net* expansion factor Y does not change appreciably with slight departures from the standard shape of Venturi throat. Consequently in practice where individual calibration is required, it is more convenient to determine C as above and take Y from data previously obtained on the standard shape.

For all fluids, the meter coefficient C is related to the Reynolds number, or turbulence as it is known, VDW/U, where D is pipe diameter, V is velocity, W is density and U is viscosity of the fluid. This is according to the method of similarity as developed from rigorous theory confirmed by a mass of accepted data of unquestionable accuracy. The relation between Venturi tube coefficients and the Reynolds number is shown in Fig. 1.

For gaseous fluids the expansion factor Y depends primarily upon the relative densities of the fluid at the inlet and section of maximum velocity. This involves the ratio x of differential to inlet pressure and the ratio n of specific heats. The convenient and commercially satisfactory basis x/n, the *acoustic ratio*, was proposed by the author as a most simple working basis for general use corresponding with the Reynolds number. The acoustic ratio, x/n, follows from the fact that the maximum velocity V is intimately related to the velocity of sound V_a so that adiabatic expansion phenomena generally are closely based upon the acoustic velocity ratio V/V_a, as early stated by Buckingham. In discussing the acoustic ratio x/n, Hodgson presented the slightly more precise basis $(1 - x)^{1/n}$ for an adiabatic expansion. The above also is according to the method of similarity and while the full treatment has only recently been developed, it has already been positively confirmed by ample and excellent data, see Fig. 2.

In practical fluid metering, the value of the coefficient C and the expansion factor Y must be definitely known beyond question. It is their relation to the Reynolds number, VDW/U, and the acoustic ratio, x/n, respectively which is important rather than that any given arbitrary definition of similarity be fulfilled. Indeed, in the present brief statement, a formal definition of similarity is not even included.

Since the Reynolds number expresses the balance between viscous and inertia forces in a fluid, its use obviously will be less needed in the highly turbulent flow accompanying high Reynolds numbers than at lower values where the effects of viscosity cause appreciable variations from a flat coefficient. However, in the case of any given meter, even at high Reynolds numbers, there is a definite relation between the Reynolds number and the coefficient C. For any given Reynolds number there will be a similar velocity distribution and correspondence of streamline direction, consequently an identical coefficient regardless of the individual values of the separate variables V, D, W and U. Hence the flow may fairly be said to be "similar" at identical Reynolds numbers. It is possible to derive the Reynolds number by a surprising number of independent methods of physical and mathematical analysis, although it was originated by the use of the principle of dimensional homogeneity, i.e. dimensions as well as units must balance in any true equation.

To carry the method of similarity from one size of meter to another of the same *shape* but larger requires no new criterion, but merely that exact geometrical similarity be achieved within sufficiently close limits that the value of the coefficient will not be appreciably affected. This simple requirement is not always easy to meet exactly in practice: roughness of the pipe enters, since it affects the velocity distribution at the inlet of the meter. Large and small pipes having the same finish are not similar, the smaller pipe being relatively rougher. However, the scale effect of the roughness in practice generally becomes a mere "vernier" correction to the method of similarity for the failure to achieve exact geometrical similarity. In any case, the most precise experiments conclusively show that where *exact* geometrical similarity of the shape (including roughness) of the meter is achieved, *exact* similarity of flow follows as evidenced by *identical* coefficients at given Reynolds numbers, regardless of the absolute size of the meter.

In the manufacture of fluid meters, there are necessarily small variations in the dimensions and finish of meters having the same nominal sizes. Failure, within certain limits, of two orifices of the same size to give exactly identical coefficients at the same Reynolds number may be reasonably expected on account of the effects on the flow of even minor deviations from the standard shape. This slight failure certainly cannot be fairly termed a discrepancy in the method of similarity, any more than the above-mentioned scale effect.

The Herschel Standard Venturi Tube has only slight tolerances in dimensions and finish since the makers aim to maintain exact geometrical similarity. Consequently there is correlation of coefficient and the Reynolds number, with only a slight scale effect for sizes having larger than 2-in. throats, this effect

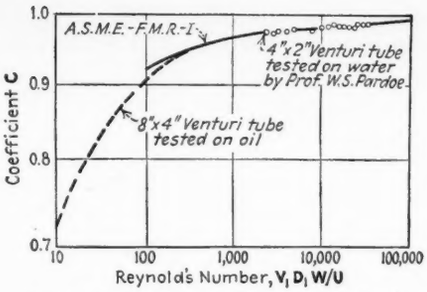


Fig. 1—Coefficient of Herschel standard Venturi tube related to Reynolds number

being much less than for thin-plate orifices. Even with Venturi tubes, however, highly precise weighed-water or volumetric tests in a modern hydraulic laboratory permits the coefficient for an individual tube to be determined slightly more closely than from the mean of all previous data on similar tubes.

The Venturi nozzle is of more recent origin and the shape may not yet be considered completely standard, as an effort is still being made to vary this slightly in the case of individual meters, which are being calibrated to approach as closely as possible to perfection before finally standardizing the form of this increasingly important differential producer. Some years ago the author conceived the possibility of obtaining a flat coefficient for the Venturi nozzle over a wide range of Reynolds numbers by balancing the slight drop of the Venturi coefficient at low rates with the corresponding slight rise of coefficient of an orifice (due to the contraction). Also, since the Venturi nozzle coefficient drop at low rates is primarily due to the effect of viscosity, in some instances the inlet of a Venturi nozzle has been intentionally roughened with a "phonograph" finish to break up the viscous film or flow along the wall and thus minimize the deviation from a flat coefficient due to this cause. Further, Hodgson recently laid emphasis upon having the throat pressure taps immediately at the end of the nozzle's throat curve.

However, it has occasionally happened that the variations of coefficients of the individual Venturi nozzles, which were not exactly similar, has been misconstrued as a failure of the method of similarity, and also the shorter Venturi nozzle mistaken for the Herschel Standard Venturi Tube. For example, in the report of current research in the May 26, 1931, number of *Power*, on page 841, it was stated that:

In regard to flow nozzles and orifices:

"The probable error of an individual observation is less than in the case of the Venturi meter, but the loss of head is much greater." Also, in regard to Venturi meters:

"The coefficients vary with the velocity and diameter, but show no relation to Reynolds number."

On the first statement, the author believes that the first remark does not apply to present Herschel Standard Venturi Tubes. Years of manufacture have resulted in geometrically similar Venturi tubes having a consistency of coefficients entirely within usual commercial requirements. In these Venturi tubes, the use of a number of proper piezometer holes with an annulus permits the mean inlet and throat pressures to be obtained with an accuracy not approached by any single side wall tap for commercial flow nozzles or orifices, especially where poor upstream conditions exist.

The second statement (based presumably upon tests with water) that "Venturi meter coefficients show no relation to the Reynolds number" is directly contrary to considerable accumulated data upon the Herschel Standard Venturi Tube. There are additional data from independent sources upon Venturi tubes and orifices upon oils and other viscous liquids as well as for water. With tests made only upon water, the variation in the coefficient occurs at such low velocities and differentials as to raise a reasonable question as to the value of any hydraulic data in this region.

Tests of a 4x2 in. Herschel Standard Venturi tube on water at the University of Pennsylvania are shown in Fig. 1.

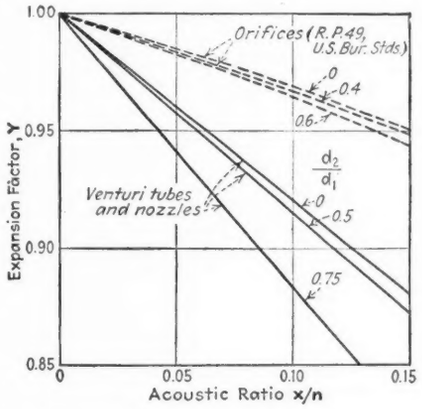


Fig. 2—Expansion factor related to acoustic ratio

These agree very closely with the mean of previous data on a number of Venturn tubes of various sizes as summarized by Dr. E. Buckingham in the A.S.M.E. Fluid Meter Report—Part I. This summary is also consistent with data on an 8x4 in. similar Venturn tube tested on oils of various viscosities and densities. Thus, Fig. 1 clearly shows that the Venturi coefficients are directly related to the Reynolds number, since the data include wide variations of velocity, diameter, density, and viscosity.

In conclusion:

(1) Calibration data obtained with water for any fluid meter may be plotted against the Reynolds number and then used with any other liquid of known density and viscosity over the same range of Reynolds numbers.

(2) Wherever precise data have been obtained upon *truly similar* meters, regardless of their size, the coefficients have been related to the Reynolds number.

(3) Size enters only as it affects the relative roughness of the surface of pipes or meters. The coefficient is less affected by size with Venturi tubes than with orifices.

(4) The Venturi tube has long been standard following Herschel's original design, as made by the original manufacturer, and the relation of its coefficients to the Reynolds number is accurately known. With the Venturi nozzle, slight modifications in shape are still being made on calibrated meters to determine the final standard shape.

▼ ▼ ▼

Blocking End Retorts of Underfeed Stokers

By H. H. Baumgartner

IN THE number of May 26, readers of *Power* submitted their comments on the effect of blocking of a side retort on an underfeed stoker. It is my opinion that the root of the matter has not been touched.

It has been the practice of stoker manufacturers to offer stokers anywhere from a few inches to 4 ft. narrower than the boilers they are built to serve. Many furnaces are so equipped. The result is that the part of the boiler directly above the stoker width operates at much higher rating than those tubes outside of the stoker line. The latter operate at lower rating because less gas flows past their heating surface.

If the space between the sides of the stoker and the side walls on a line plumb from the outside boiler tubes is filled in with a 45-deg. sloped wall, the fuel will slop over onto this sloped portion and tend to produce a larger fuel burning surface.

Making the end retort plungers inoperative and covering these retorts with a 45-deg. sloped wall, using interlocking silicon-carbide skew brick, will result in a narrower fuel bed, which will be alive to a proportionately greater depth. In fact, if the blanking off is properly done a full active fuel bed will result. The savings due to the ability to operate with low excess air will more than offset the decreased efficiency of the heating surface so that a considerable increase in efficiency may be expected.

The grate surface will burn twice the coal per square foot if the side wall is sloped from the center line of the tuyeres next the retorts blanked. By starting the slope on a line with the outside of these tuyeres a better job could be obtained and the grate would operate at approximately 35 per cent greater coal burning rate per square foot.

The construction described above prevents air flow through the unused portion of the stoker and at the same time avoids burnouts because of exposed grate surface.

It is safe to assume at least 10 per cent increase in efficiency will be obtained by the decreased excess air.

National District Heating Association Meets in Pittsburgh

MEMBERS of the National District Heating Association convened at Pittsburgh, Pa., on June 14 to attend the twenty-third annual convention of the Association. The opening session was devoted to the President's address and reports of various committees.

At the first technical session in the afternoon the committee on Meters and Accessories and the Sales Development Committee presented their reports. The meters committee report contained a discussion of the use of aluminum for condensation meter bodies, proposed specifications for the manufacture of steam condensation meters, a balanced seal method of trapping building heating systems and a discussion of reducing valves. In discussing the report, Mr. Hillemyer of St. Louis reported that a condensation meter with an aluminum case has been in operation in St. Louis for eleven years.

At the second technical session held on the morning of June 15 the Station Operating and Hot Water Committee presented reports. The Station Operating report discussed six topics, among them being: "The Selection and Utilization of Fuels," by J. R. McCousland; "Continuous Blow-Down Systems," by A. R. Mumford; and "Operating Experience with Pease Anthony Gas Scrubbers," by M. D. Engle.

In presenting the paper Mr. Engle said that the removal of ash from the flue gas has been so successful that there was not enough ash remaining to scour the paint off the blades of the induced-draft fans.

O. J. Slade gave an address on "District Heating in Europe" in which he reported that it was common in Europe to care for pipe expansion by means of plain and corrugated pipe bends. Concrete conduits are generally used. In Denmark "cell concrete" has been used for insulation, the porous material being poured around the pipes forming a solid block.

Reports of the committees on Commercial Relations, Rates and Regulations, and Research were presented at Thursday morning's session. Abstracts from these reports follow:

Hot Water Requirements of Buildings

Average hot water requirements for the twelve office buildings studied are 12.1 lb. of hot water per day per 1,000 cu.ft. of building volume. This is 11.3 per cent of the total amount of water used by these buildings. The maximum demand for hot water, similarly determined and averaged for the office buildings, is 1.18 lb. per hr. per cu.ft. of building volume. It is noted that there exists a great variation in the amount of hot water used by the buildings studied, varying all the way from 2.6 lb. per 1,000 cu.ft. per day to 101 lb. per 1,000 cu.ft. per day. The building which reported this latter high consumption is an office building in which there are two restaurants, three beauty shops and one barber shop.

The average amount of hot water used by six hotels reporting was 58.5 lb. per day per 1,000 cu.ft. of building volume. Maximum demand for these hotels was 6.09 lb. per hour per 1,000 cu.ft. Steam required to heat hot water is reported for four of the buildings. Steam consumption varies from 0.95-2 lb. per gal. of water heated.

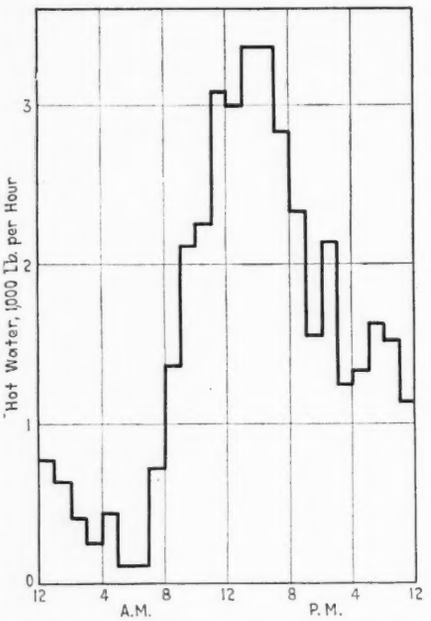


Fig. 1—Hot water consumption in a 40-story office building of 4,440,000-cu.ft. gross volume

Curves showing a variation in hot water requirements during the day are shown in Figs. 1 and 2. The curve for office buildings indicates that in general the water heating load does not come on as early in the morning as the steam heating load and that storage capacity should be provided for water heated in the economizer if heat is to be salvaged from the condensate during the warming-up period.

Steam Consumption and the Degree-Day

To obtain additional information on the relation between the amount of heat required by buildings and the outdoor temperature the National District Heating Association in cooperation with other organizations collected data from 175 buildings in twenty-two cities. The result was reported by the Commercial Relations Committee.

Some years ago a unit known as the "degree day" was originated by the gas industry for estimating fuel consumption at different outdoor temperatures. It is defined as the difference of 1 deg. between the base temperature and the mean outdoor temperature for a day. The number of degree-days in any period is the summation of the difference between the base temperature (65 deg. F. for the standard degree-day), and the daily mean temperature below 65 deg. The base of 65 deg. for the degree-day was originally chosen because it was found that the amount of gas required for heating residents was proportional to the difference between 65 deg. and the outdoor temperature. Thus at this temperature the steam consumption for heating would be zero.

For each building upon which data was obtained the report shows the outside temperature for zero heating-steam consumption. These buildings have been classified and the average temperature of each class is given in the following tabulation:

	Deg. F.
Office buildings	66.2
Office and bank buildings	65.8
Banks	66.2
Office and telephone exchanges	65.5
Stores and offices	67.4
Stores	64.0
Department stores	64.3
Hotels	66.5
Apartments	68.8
Residents	66.9
Clubs	65.5
Theaters	67.6
Warehouses and loft buildings	65.2
Manufacturing	65.4
Average for 175 buildings of all types	66.0

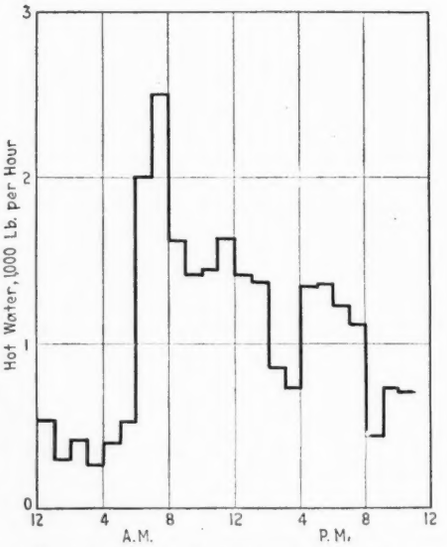


Fig. 2—Hot water consumption in a 14-story hotel of 1,155,600-cu.ft. gross volume

These results were arrived at by dividing the monthly steam consumption of each building by the number of days in each month, thus giving the average daily steam consumption by months. The average steam consumption was then plotted against the mean average

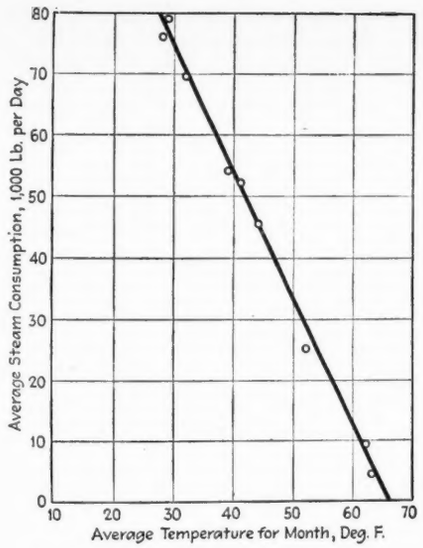


Fig. 3—Relation between average steam consumption for building heating and outdoor temperature in a 40-story office building

monthly temperature, as shown in Fig. 3. The temperature at which a line drawn through the points crossed the zero steam consumption line was noted and listed in the table. In Fig. 3 the line crosses zero at 65.6 deg., and it is obvious that steam consumption at any lower outdoor temperature is proportional to the difference between that temperature and 65.6 deg. In every case the relation between temperature and steam consumption was a straight-line relation, although in many cases the points were scattered more than in Fig. 3. In general, the buildings in which the temperature was carefully regulated gave the most orderly results.

In the discussion Mr. Seiter thought that as a basis for comparing steam consumption in buildings, connected radiation is to be preferred over building volume. Mr. Arthur pointed out the effect of heat from lights on steam consumption in a building. He also reported that it was possible to save 25 per cent of the steam for water heating by reducing the water temperature. Mr. Seiter called attention to the large amount of steam used for water heating in restaurants.

Abstract Report of the Sub-Committee on Corrosion

The Sub-Committee on Corrosion of the National District Heating Association, in its report tendered a description of a corrosion tester which has been evolved from the Chapman tester described in the 1931 report of the committee. Construction of this tester is shown in the illustration. It consists of a standard $\frac{3}{4}$-in. pipe plug into which is inserted a brass retaining frame. The corrosion specimens consist of three helical coils mounted in the frame and insulated from one another and from the supporting frame by Micarta couplings. The terminal Micarta couplings are threaded into the frame and the pipe plug.

The coils are made from a specimen of steel wire 0.05 in. in diameter with a tolerance of plus or minus 0.005 in. The coils are approximately $\frac{1}{8}$-in. outside diameter and 1 in. long and weigh approximately 3 grams. This presents for corrosive action aproximately 2 sq.in. of surface. The wire used in making these coils has the following analysis:

Phosphorous 0.1 per cent, sulphur 0.07 to 0.08 per cent, manganese 0.4 to 0.10 per cent, carbon 0.08 to 0.10 per cent.

Before the coils are mounted in the tester they are put into a glass containing ether or carbon tetrachloride and equipped with a reflux condenser. The solvent is boiled for approximately 30 min. The coils are then removed from the solvent, dried at a constant temperature of 107 deg. C. for two hours and then weighed on a delicate balance. Subsequently, they are mounted in the tester, care being taken to keep accurate account of the weight of each coil and its place.

In determining the rate of corrosion due to steam, from whatever source it may be developed, it is recognized that it is condensed steam containing dissolved carbon dioxide and oxygen that cause corrosion. Therefore, the test specimen should be placed so that the condensed steam passes over the test specimen. A relatively large number of tests have shown that approximately 28 days is sufficient to obtain a large enough loss of weight of the specimen to be significant. The most severe conditions of corrosion so far encountered have shown a loss of weight of 0.5 grams, and the least corrosive condition encountered a loss of 0.05 grams, in 28 days. These figures are of significant magnitude since the total original mass is only about 3 grams.

The corrosion rate is computed from the difference in the initial weight of the coil and the weight after corrosive products have been removed and the total area exposed to corrosion. The corrosion product may be removed by immersing the coils in a 15 per cent solution of sulphuric acid containing 5 per cent of an inhibitor.

With this method of removing the corrosive product it has been found that a slight etching of the iron occurs. Experiments, however, indicate that the loss of weight from this source is usually not of much consequence and does not affect the results of the calculated corrosion rate. The formula used in computing the corrosion rate is $R = \frac{A}{B \times C}$, where R equals corrosion rate as average penetration in inches per year, A equals loss of weight in pounds per square inch, B equals weight of metal in pounds per cubic inch (0.2782 lb. for the wire described), and C equals duration of the test in years.

Mr. Walker presented results obtained with a newly-developed corrosion tester. The data from three cities indicated that the testers placed in the return piping of vacuum systems corroded at about twice the rate of those in pressure systems. The data also

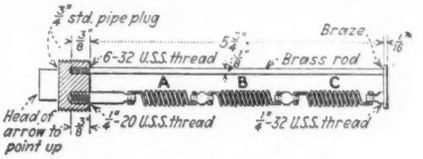


Fig. 4—Detail of corrosion tester

showed that the district steam as furnished had very little corrosive effect as compared with the condensate from the building steam risers and return mains. In vacuum systems the condensate in the buildings was in most cases ten to fifteen times more corrosive than condensate from the steam as furnished. This was attributed to the air pulled in or to intermittent operation. Remedies suggested were (1) Improving building heating systems to reduce air leakage (2) Possibly adding some neutralizing material to the steam to overcome the effect of air leakage.

Mr. Speller stated that it was not probable that a low-cost ferrous alloy would be found to take the place of steel and wrought iron and that it would be better to look to protective coatings to prevent corrosion.

Officers elected for 1932-1933 were president, E. E. Dubry, first vice-president, J. E. Hillemeyer, second vice-president, Wm. J. Baldwin, Jr., third vice-president, R. L. Fitzgerald, secretary-treasurer, D. L. Gaskill. Chicago was selected for the 1933 convention, which will be held in June.

An Addition and A Correction

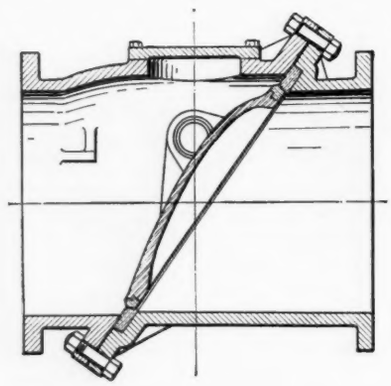
SLAG FORMATION: In the article on "Causes and Control of Slag Formation" by James L. Corcoran in the May 3 number of *Power*, acknowledgment was made to The University of Illinois Experiment Station, the U. S. Bureau of Mines and the Prime Movers Committee of the N.E.L.A. Space prevented the inclusion of a rather complete bibliography on the subject which the author has prepared. Special mention should have been made that some of the information was based on a report made by Dr. H. F. Johnstone of the Dept. of Chemistry, University of Illinois, for the "Chemists Sub-Committee of the Prime Movers Committee," N.E.L.A. This applies especially to the idea of agglomeration temperature controlling slag accumulation.

POWER FOR HOTELS: In *Power* of June 14, L. E. Habben analyzed the power and heat supply for hotels. Curves, Figs. 1 and 4, were incorporated to show the similarity of the summer and winter electrical loads. The actual quantities indicated as ordinates have no bearing and should be disregarded, as it is the form of the curves that counts. As explained in the text, these were plotted to a common ordinate.

WHAT'S NEW IN PLANT EQUIPMENT

Tilting Disk Check Valves

CLAIMED as a radical departure from all present types of check valves and capable of being used as a stop-valve with slight modification, this valve by Chapman Valve Mfg. Co., Indian Orchard, Mass., is known as the "tilting



disk" valve. It consists essentially of a rigid circular disk pivoted within a cylindrical housing. Seats are of the circular bevel type, and the disk drops cleanly into contact without rubbing. The disk rotates about fixed pivots, offset from the seat. Pivots are bushed with nitrided steel. The unit is claimed to overcome slamming at closing, large losses of head, and severe wear of moving parts. Sizes vary from 3 to 48 in. for any working pressure.

Steel Apron Conveyor

THE "Gravity Seal" steel apron conveyor is being introduced by the Webster & Weller Manufacturing Co., Chicago, Ill., for long-time operation under severe operating conditions. The gravity seal feature is based on a new method of attaching the conveyor pans to the chains by means of a patented pivot link. It is the operation of this link in connection with several minor and constructional features that causes the pans to overlap in order to eliminate leakage of material and yet provides sufficient flexibility to enable the conveyor to travel without strain evenly around sprockets. The cross rods mounted through the center of the chain links are fitted with hardened bushings. All roller parts may be replaced easily. Each pair of rollers carriers the load of two full pan pitches on both the carrying and return run of the conveyor and rollers are idle only while the apron passes over the sprockets. This construction is applicable to both apron conveyors and apron feeders and has been developed primarily to withstand abrasive action of material.

New Graphic Instruments

AMONG the features embodied in the new line of graphic recording instruments put out by Esterline-Angus Company, Indianapolis, Ind., are spring clocks of removable units, escapement, spring barrel and gear train.

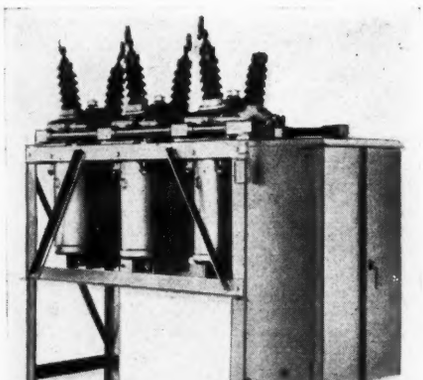
Another innovation is that all three springs in the clock are wound at one time by means of a simple crank, instead of the familiar clock key. This is done from the front of the meter, so that it is no longer necessary to space instruments apart on a switchboard in order to leave room for winding the clock. Also all instruments are arranged so that the rolls which drive the chart can be coupled together, accurately synchronizing the charts. The coupling is placed back of the gears which fix the chart speed, so that instruments operating at different chart speeds can be coupled up.

An assortment of electrical synchronous motor clocks is offered for driving the charts. Both these and the spring clocks give chart speeds ranging from $\frac{3}{4}$ in. an hour to 12 in. a minute.

Another interesting development is an instrument which is used for recording quantities which are changing rapidly. The meter operates at a slow chart speed when the values measured are steady, but when sudden and rapid changes are to be recorded, the chart automatically speeds up instantly to 3,600 times the slow speed, and like a "slow motion" film, records the rapid changes which take place. When conditions become normal, the chart is re-set to the proper time, and slow speed is resumed again.

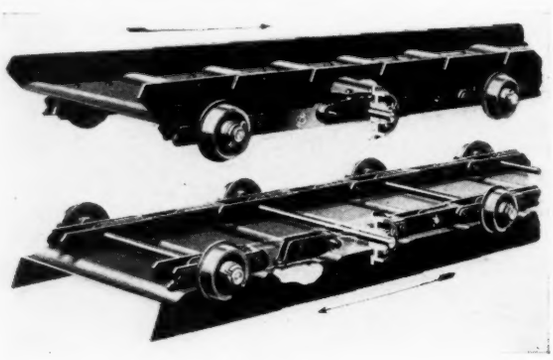
The new instruments are made in portable, switchboard flush, switchboard front and wall type cases. In addition, all but the portable are made in double or twin types, which consist of two recorders in one case.

The entire line comprises twenty-two different kinds of recording instruments, including A.C. and D.C. ammeters, wattmeters, and voltmeters, recorders for speed, vacuum, high- and low-pressure, frequency and power factor, time and production, motion and position, and water level.



Outdoor Oil Circuit Breaker

AN OUTDOOR oil circuit breaker of moderate interrupting capacity, known as Type O-12, for outdoor distribution services at 23 kv. or less, has been announced by the Condit Electrical Mfg.



"Gravity Seal" apron conveyor at left, Esterline-Angus switchboard and portable graphic recording instrument at right

Top—Capable of measuring vertical and horizontal vibrations simultaneously, the Davey Model S-2 Vibrometer is simply placed upon the machine whose vibration are to be measured

Left—A safety pilot switch with but three moving parts is used in the Series C Mettler conversion burner unit. The unit, completely assembled, is simply set in place

Corp., 1344 Hyde Park Ave., Hyde Park, Boston, Mass. The breaker is of weather-proof construction throughout, with top units of cast steel reinforced to afford a rigid foundation for the bushings and mechanism. A continuous gasket is inserted in a groove on the under side of each breaker top against which the tank fits, and a deep reinforcing flange extends down over the tank. Tanks are of steel plate, elliptical in shape. They are drawn into place against the gaskets by short tank bolts. Emission of oil is thus claimed to be minimized. Main current carrying members are Condit inverted laminated brushes, designed to withstand high inrush current. Brushes are protected on opening and closing by large arcing contacts whose thermal absorption capacity is such as to reduce arcing on interruption materially. The Type O-12 is furnished for 600 and 1,200 amps. at 15 kv. and 600 amps. at 23 kv., with an estimated interrupting capacity of 175,000 kva. at 15 kv. and 150,000 kva. at 23 kv. It is furnished manually or electrically operated, a.c. or d.c. Electrically operated breakers may be arranged for automatic reclosing service.

Conversion Burner and Automatic Safety Pilot

SERIES "C" conversion burner units and the Mettler improved automatic safety pilot are being introduced by the Lee B. Mettler Co., 406 South Main St., Los Angeles, Calif. The Series "C" triple control unit consists of a Mettler gas burner encased in a steel jacket, provided with an air damper to be operated either automatically or by hand; an automatic electric motor valve of the latest type; safety main and pilot light valves; and the new Mettler pilot light with safety switch. Units are assembled complete with piping and fittings.

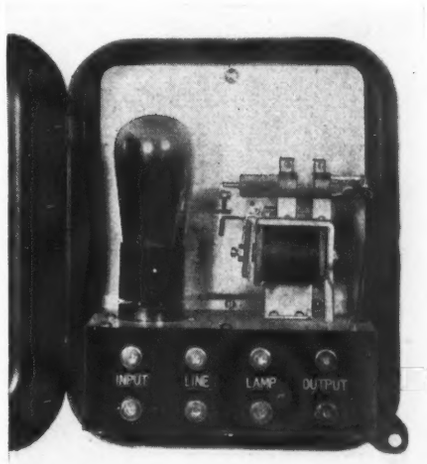
The automatic pilot switch is claimed to consist of only three parts: pilot light tube with thermostatic element; base containing the gas supply pipe and nozzle for the pilot light, electric terminals and the stationary contact point, and an outer safety cover. No adjustment of the contact points is needed, and since the heat from the pilot flame is the only actuating force on the thermostatic element, there is claimed to be no time lag.

Vibration Measuring Instrumen

THE Model S-2 Davey Vibrometer, capable of measuring vertical and horizontal vibrations simultaneously, is being introduced by Electrocon Corp., 6 Varick St., New York, N. Y. The instrument is simply laid down on the object whose vibrations are to be measured, and a spot of light traces out the exact path of the vibration, magnified many times, on a ground glass scale. It will measure frequency and phase position in addition to amplitude if used in conjunction with the Davey portable balancing equipment. The illustration of the circular ground glass scale, which is actually 4 in. in diameter, shows the way a typical vibration reading appears. The instrument works on the principle of the Seismograph, and will indicate accurately the amplitudes of vibrations of frequencies above 400 per min. and up to approximately 6,000 per min. It is available in two sensitivities, Model S-2A which magnifies vibrations approximately 500 times and Model S-2B which magnifies approximately 250 times. Photographic records may be obtained of any repeating vibration.

Electronic Micro Relay

CONTROLLING a current of six amperes at 220 volts positively with the minute flow of one one-millionth of an ampere, the Burgess Micro Relay is being manufactured by the Electronic Division Staff of C. F. Burgess Laboratories, Inc., 202 E. 44th St., New York City. It is claimed to transform normally indistinguishable contacts into readily distinguishable powerful forces, and is used for temperature control work, go and no-go, and maximum and minimum control settings on sensitive indicating meters and other apparatus. It is recommended by the manufacturer where it is desired to provide indication or control at some predetermined value as shown by an indicating instrument, or in industrial equipment wherein



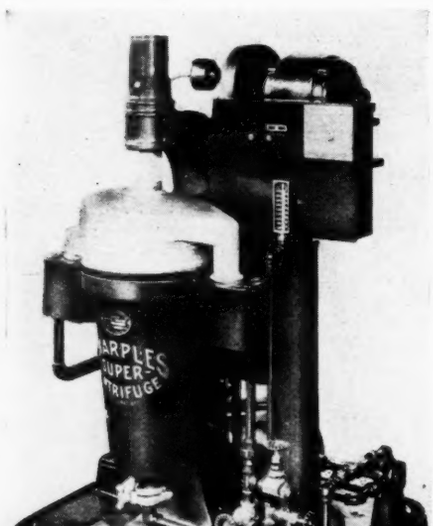
positive action must be obtained by the closing of an electrical circuit through a pair of contacts under slightest pressure.

It consists of an electronic tube in the plate circuit of which is a normally closed mechanical relay, the relay being held open by the residual value of plate current with an unbiased grid. The controlling contacts are so wired that when they come into contact a negative bias is placed on the grid, to cause the relay to close. Components of the relay are mounted in a metal cabinet measuring $7 \times 8\frac{1}{2} \times 4\frac{1}{4}$ in. A terminal

strip inside the cabinet provides for connections with the external circuits. Knockouts permit of permanent wiring using BX or conduit. The relay is arranged to operate with a standard 25-watt lamp wired in series with the filament of the tube, and serving the triple purpose of a resistor, pilot light to indicate that the relay is operative, and illuminator for the indicating instrument to which it is attached. The mechanical relay of the unit is provided with a Burgess vacuum contact in place of the usual exposed contact points. This permits handling of currents up to 6 amperes at 220 volts.

Oil Purifying Unit

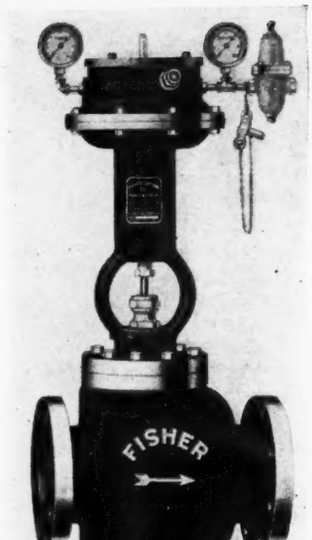
A COMPLETE oil purifying plant designed especially for purification of diesel engine fuel and lube oil, turbine lube and other miscellaneous types of lube oil, is announced by the Sharples Specialty Co., of Philadelphia, to be known as the



Sharples EN Bloc oil purifier. It is a complete oil purifying plant, combining an oil purifier of high centrifugal force with pumps, heaters, push button controls and accessories, all mounted on a common base and piped and wired together so that the installation requires but two pipe connections and one electrical. The Sharples super centrifuge of the inclosed vaportight model is used to remove impurities, such as dirt and grit from the oil. The super centrifuge develops a force of over 13,000 times gravity.

Steam Regulator

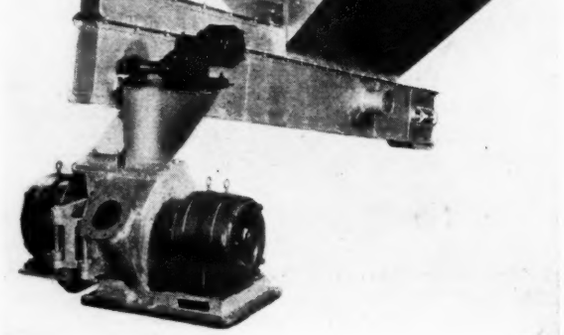
DEVELOPMENT of the Series 4200 wizard pilot unit, which involves a design that includes the pilot valve as an integral



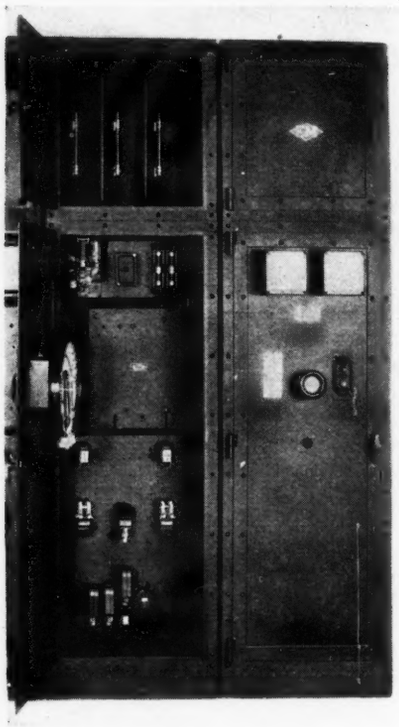
part of the main valve top work, has been announced by Fisher Governor Co., Marshalltown, Iowa. The unit utilizes auxiliary air or gas as an operating medium and is suitable for pressure conditions of 5 lb. and up. It is converted easily from a pressure reducing valve to a pressure relief valve by a simple change in the pilot valve. It is furnished complete with a small auxiliary regulator shown attached and with the pressure gage. Bulletin 70 describes the unit.

Pulverizing and Direct-Firing Unit

A DIRECT-FIRING unit used where the equivalent in heat of 10 lb. of coal an hour or more is required, is being manufactured by Holbeck Direct-Firing Unit Corp., 5151 St. Clair Ave., Cleveland, Ohio. It is claimed to be quiet in operation, without metal-to-metal grinding and to have but three wearing parts. It operates automatically under control of pressure or temperature switches. It

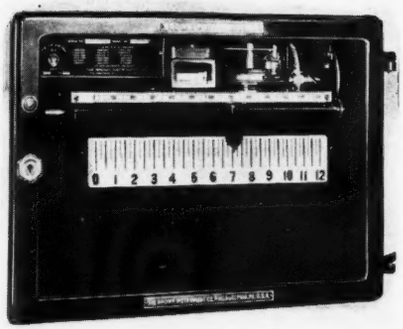


is compact. The unit for 1,500-sq.ft. boiler for example, takes a 20x30-in. space. It is capable of pulverizing coal so that 85 per cent passes through a 200-mesh screen. Wear on the unit is claimed not to affect the fineness of pulverizing, and one unit is considered capable of firing any number of boilers up to its capacity. Sizes vary from 10-in. through 12, 14, and 18-in. to larger sizes burning up to 25 tons of coal per hour. The 10-in. size is capable of handling up to 150 lb./hr.



Cubicle Starter for Synchronous Motors

CUBICLE-TYPE automatic starters for synchronous motors are being used increasingly, particularly in installations where the starter is to be placed out in the mill room with the motor, or where the open type starters are undesirable because of atmospheric conditions. One type of cubicle starter for synchronous motors recently developed by Electric Machinery Mfg. Co., Minneapolis, Minn., uses a front compartment for the meters, control relays, rheostat and field contactor; a rear compartment for the oil-break line switches; and an upper compartment for the disconnects. The starter is designed to permit easy access to working parts.



Self-Balancing Indicating Potentiometer

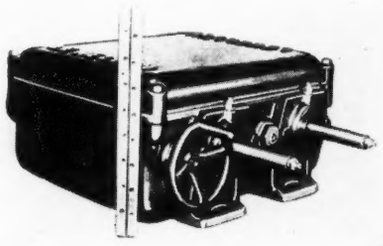
AN INDICATING potentiometer of the self-balancing type has been added to the potentiometer line of Brown Instrument Co., Philadelphia Pa. Most indicating potentiometers hitherto have required hand balancing. Aside from this design feature, the potentiometer has an unusually long (40 in.) slide wire, positive spiral shaft drive, a non-slip clutch, a secondary pointer definitely fixing the size of step in moving the slide wire contact, interchangeable case for universal mounting, mechanism swings out of case for easy inspection without interference with operation, mercury-in-glass switches in control models, automatic thermal equalization between cold junction terminals and compensation coil. As a pyrometer this instrument can be supplied for any range from 0 to 100 deg. F. up to 0 to 3,000 deg. F. or for almost any span between these ranges. Models for automatically controlling as well as indicating temperatures can be furnished.

Variable-Speed Transmission

LEWELLEN Mfg. Co., Columbus, Ind., has announced its smallest-size variable-speed transmission, Size 106, a fully enclosed type. Comparison with the rule in the picture gives an accurate idea of its dimensions.

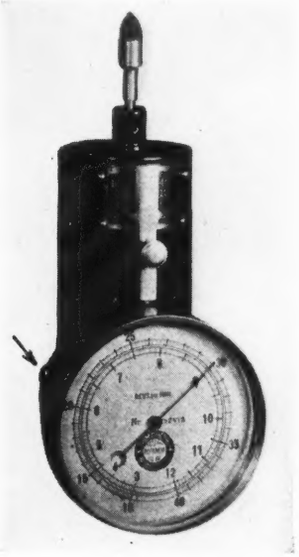
The Size 106 has the capacity of $\frac{1}{4}$- or $\frac{1}{3}$-hp. motor, with a maximum speed range of 6 to 1. It may be completely lubricated, belt tension adjusted, etc., without removing the cover, or even stopping operation. All working parts are sealed against acids, abrasives, liquids, steam, etc.

Series 100 Lewellen Transmissions are built in all sizes up to 15 hp.



Hand Tachometer

AMTHOR Testing Instrument Co., 309 Johnson St., Brooklyn, N. Y., has put out a direct-reading Type 350 hand tachometer for finding r.p.m. machine speeds. It incorporates automatic fixed

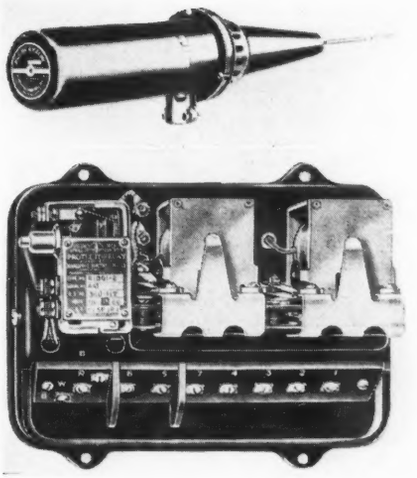


reading whereby the speed reading is automatically fixed on the dial each time the instrument is used. On an ordinary tachometer the pointer drops back to zero once it is taken away from the machine being tested. The dial is graduated to read directly in r.p.m., but the instrument is equipped with all accessories so that ft. per min. surface speeds and belt speeds can be taken. The tachometer has four speed ranges, each separately read over the entire circumference of the dial. Various ranges can be had to measure speeds as high as 12,000 r.p.m. directly.

Automatic Safety Device for Burners

A DEVICE which is claimed to provide instant and positive protection against the escape of unburned gas or oil in the event of flame or pilot failure. The "Protectoglow," has been developed by the Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. Entirely electric and without moving parts, it is said to be independent of temperature and absolutely reliable. The Protectoglow tube, which acts as an electrical relay, operates from a minute electric current passed through the flame itself. Should the flame fail, the circuit through the flame is broken, shutting off the gas or oil flow. In the absence of pilot flame, the Protectoglow will not allow the burner to start.

The Glo-Relay is used in conjunction with the Protectoglow and serves to operate the valves or motor of the burner at the command of the thermo-



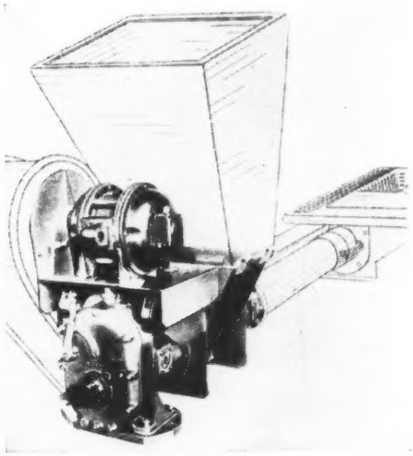
stat, control switch, or Protectoglow. It is self-contained and is available for either constant or intermittent ignition burners.

Motorized Gear Drive for Stokers

LINK-BELT Co., 2410 W. 18th Street, Chicago, announces the manufacture of a complete front-end assembly for stokers. This is a standardized unit and consists of:

1. Variable-speed stoker drive, with base.
2. Low-speed flexible coupling with housing.
3. Adjustable motor base.
4. Hopper base with cleanout door.

This unit is offered with a variety of motor mounting designs to suit individual applications. It is claimed that because of the elimination of development and engineering expense and the fact that these mechanisms will be made on a production basis that they can be offered on a much more economical basis than if the manufacturer designed and built his own unit.



Link-Belt front-end assembly for stokers, a standardized unit

NEWS of the WEEK

Electrical Congress In Paris July 4 to 12

MANY men of many nations will be included in the program of the International Electrical Congress which will be in session in Paris, France, July 4-12.

Prompted by the need of an exchange of knowledge, experience and ideas, several French engineering societies are cooperating with the Interational Electrotechnical Commission in planning the Congress. To some extent the meeting will be in commemoration of a similar assembly held in Paris in 1811, and it is possible plans may be made for a permanent organization with periodic meetings every few years.

Invitations to prepare papers for the Congress have been extended to engineers all over the world. Included in the papers to be presented by American engineers are: "Power System Stability," by R. D. Evans and C. F. Wagner, "Development of Electrical Machinery in the United States," by F. D. Newbury, Westinghouse, and P. L. Alger, General Electric, "Electric Power Development in the United States," by F. C. Hanker, Westinghouse, F. A. Allner, Pennsylvania Water & Power Co., A. D. Bailey, Commonwealth Edison, Chicago, and A. G. Christie, Johns Hopkins University. "Motors and Equipment for Electric Traction in the United States," by Norman W. Storer and Sidney B. Cooper, Westinghouse, and Frank E. Case and Max R. Hanna, General Electric.

Open Bids for Hoover Dam Outlet Pipe

Bids on manufacture and installation of outlet pipes for Hoover dam, to convey water to the nearby power plant, were opened at the Denver reclamation office June 15. Although Chief Engineer Raymond Walter did not announce the successful bidder, it is known that Babcock & Wilcox, Barberton, Ohio, submitted the lowest estimate at $9,270,000. Three other firms competed: Chicago Bridge & Iron Co.; Western Pipe & Steel Co.; and the A. O. Smith Co. Their bids ranged up to $13,624,868 and were submitted on twelve different schedules. This contract involves about 50,000 tons of plate steel and is among the largest ever authorized by the reclamation service. Final determination of the most satisfactory bid will probably be made by the interior department at Washington before July 1.

A.S.A. Plans Clean Coal Specifications

The development of specifications for clean bituminous coal will be undertaken by a technical committee under the procedure of the American Standards Association as the result of a request made by the American Institute of Mining & Metallurgical Engineers. At present it is proposed that the work of the committee should be confined to groups located east of the Mississippi River. The purpose generally includes specifications outlining allowable limits of inacceptable material in prepared bituminous coal, whether mechanically cleaned or not, in sizes coarser than 2 in., the purpose being to define clean coal and not to standardize screen sizes. Clean bituminous coal is at present simply a name with no guide or limit to determine what is meant when the term is used by coal mine operators or dealers. Refuse is inevitably present in all coal, but there are no generally accepted policies.

Fuel Oil Specifications To Undergo Revision

Under the chairmanship of Dr. H. C. Dickinson, Chief of the Heat and Power Division, U. S. Bureau of Standards, the Technical Committee on Lubricants and Liquid Fuels of the Federal Specifications Board is revising the specifications for fuel oil. Effort is being made to correlate the various existing specifications for fuel oil with the object of arriving at a universal agreement as to the several grades to be specified. Conclusions are not expected for several months.

N. Y. Section A.S.R.E. Elects Officers

The following officers have been elected by the New York Section of the American Society of Refrigerating Engineers, to hold office from the period beginning July 1, 1932: President for one year, Louis H. Roller, Brunswick-Kroeschell; first vice-president, Ira E. McFarland, Jamison Cold Storage Door Co.; second vice-president, (for two years) Eustace C. Soares, R. B. Engineering Corp.; secretary, Clifford F. Holske, Knickerbocker Ice Co., and, treasurer, Chester J. Conn, Long Island Ice Corp.

COMING MEETINGS

American Society of Mechanical Engineers—Bigwin Inn, Lake of Bays, Ont., Canada, June 27-July 1. C. W. Rice, 33 West 39th St., New York.

American Society of Heating and Ventilating Engineers—Hotel Pfister, Milwaukee, Wis., June 27-29. A. V. Hutchinson, 51 Madison Ave., New York.

Universal Craftsmen Council of Engineers. Annual convention at Cedar Point, Ohio, Aug. 8-13. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

Safety Congress and Exhibition—21st Annual, Washington, D. C., Oct. 3-7. Headquarters of the National Safety Council, Sponsor, 20 N. Wacker Drive, Chicago, Ill.

American Institute of Electrical Engineers—Pacific Coast Convention, Vancouver, B. C., Aug. 29-Sept. 2. Middle Eastern District meeting, Oct. 10-13, Baltimore, Md. National Headquarters, 33 West 39th St., New York City.

Second Conference of Smaller Industries—Silver Bay, N. Y., July 11-16. A part of the Silver Bay Industrial Institute, July 8-22. C. R. Towson, secretary, 347 Madison Ave., New York City.

Plan 10th National Power Show

SOME 293 manufacturers of power-producing machinery and mechanical devices for power transmission, precision instruments for the control of combustion, pressure, volume, flow and other measurable entity, material handling equipment, heavy electrical machinery, etc., will stage exhibits in the forthcoming Tenth National Exposition of Power and Mechanical Engineering at the Grand Central Palace, New York, during the week December 5 to 10, which is coincident with the annual meeting of the A.S.M.E. During the past two years, the interval since the Ninth Exposition, considerable research has been carried on, and results of this work will be shown at the Exposition.

According to the officials, the Exposition is equal at the present time in size to its immediate predecessors, and it is expected that many more firms will be included. The Exposition Advisory Committee comprises: I. E. Moultrop, chairman, of Edison Electric Illuminating Co., of Boston, with Homer Addams, past president, American Society of Heating and Ventilating Engineers; N. A. Carle, manager, Pasific Electric & Mfg. Co.; Fred Felderman, past-national president; National Association of Stationary Engineers; C. F. Hirshfeld, chief, Research Department, Detroit Edison Co.; O. P. Hood, Chief Mechanical Engineer, U. S. Bureau of Mines; C. N. Lauer, president, the American Society of Mechanical Engineers; John H. Lawrence, Thomas E. Murray Co.; Fred R. Low, past-president, the American Society of Mechanical Engineers; Glenn Muffly, president, American Society of Refrigerating Engineers; David Moffatt Myers, consulting engineer; and Charles F. Roth and Fred W. Payne as co-managers of the Exposition. The Exposition is being conducted by the International Exposition Co., with offices at Grand Central Palace, New York, N. Y.

Honor Frank Sprague at Tribute Meeting

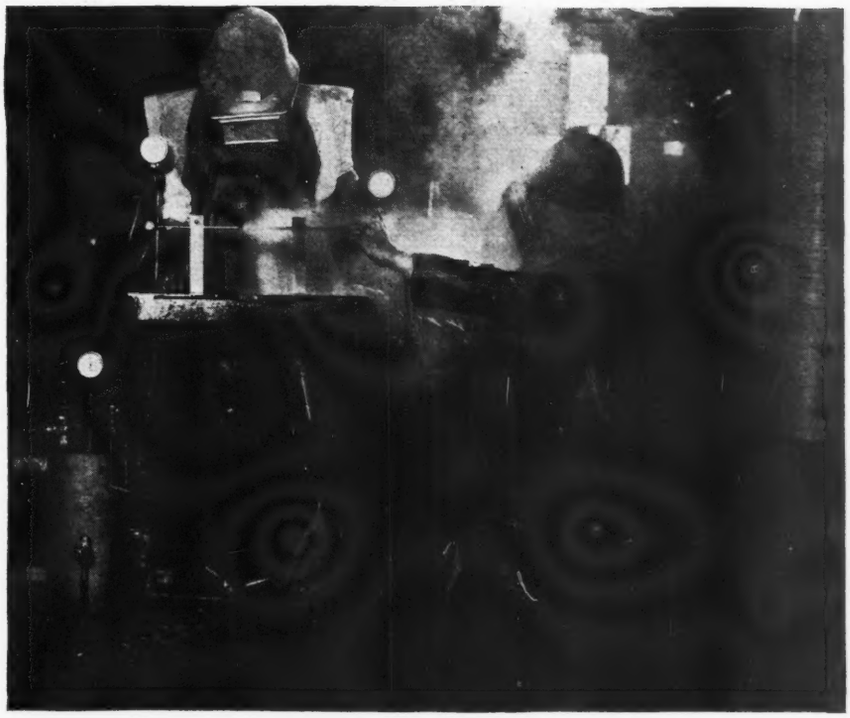
FRANK JULIAN SPRAGUE, scientist, inventor, engineer and "father of electric traction," will be honored at a meeting of appreciation and tribute in the Engineering Societies Building on July 25, on the occasion of his 75th birthday. Mr. Sprague, who was born in Milford, Conn., July 25, 1857, was at one time assistant to Thomas A. Edison, organized the Sprague Electric & Motor Company, developed electric elevators, organized the Sprague Electric Elevator Co., and invented a system of automatic train control. He developed a constant-speed electrical motor, demonstrating the practicability of motors for railway use in established present standards, which insured successful electric railway operation. He also was the man who pushed alternating-current development, and designed the systems of remote control and equipment for elevator operation now universally used.

Detect Mercury Vapor in Flue Gases

A method for "weighing" as little as 1/3,000,000th of an ounce of material by "looking" at it with a little cathode ray tube, and a system for automatically detecting a few drops of mercury in a furnace through which more than 200,000 lb. of flue gas pass each hour, were among the subjects discussed by General Electric engineers at the semi-annual meeting of the American Institute of Chemical Engineers in Schenectady, June 15 and 16. About 175 members of the Institute were present for the meetings, which included technical sessions in the mornings. A general program regarding General Electric research laboratory the first afternoon, the dinner of the Institute that evening, and an outing on the second afternoon.

Describing the installation at Hartford, and citing some of the operating figures, A. J. Nerad said the thermal efficiencies attainable with the Emmet mercury-vapor process are higher than those of steam processes, and that the operation at Hartford has proved an advance in this respect in actual results over contemplated steam processes. The simplicity of operation has proved one of the features of the system, and the changes which were required by continuous operation have been few and simple. It is to be expected, according to the speaker, that the new 20,000-kw. units now under construction will result in a similar expansion of the use of mercury in power generation.

A simple but efficient fume detector is used to detect possible leaks and losses of mercury. It depends for its action on the fact that selenium sulphide, a yellow compound, is blackened by exposure to mercury fumes; and the degree of discoloration is a measure of the amount of leakage when conditions of contact are controlled. A photoelectric tube "keeps an eye" on a strip of paper that is coated with selenium sulphide. If the paper should become blackened by mercury, the amount of light reflected from the paper to the phototube is reduced, an electric circuit is affected, and a bell is rung, a light is flashed, or some other signal warns the operator that mercury vapor is being found in the stack gases.



Superfine atomization, resulting in the breaking of a furnace oil globule the size of a match head into 100,000,000 particles, speeds and betters combustion. Here General Electric engineers are showing how it is done

Purchase Plant

The Brantford (Ont.) Hydro-Electric Commission has purchased the Western Counties Electric Co. for $200,000.

PERSONALS

H. P. CHARLESWORTH, vice-president, Bell Telephone Laboratories, Inc., New York, N. Y., was elected president of the American Institute of Electrical Engineers for the year beginning Aug. 1, 1932, as announced at the annual meeting of the Institute in Cleveland, Ohio. Other officers elected were—Vice-Presidents: J. Allen Johnson, Buffalo, N. Y.; E. B. Meyer, Newark, N. J.; K. A. Auty, Chicago, Ill.; G. A. Mills, Dallas, Tex.; C. R. Higson, Salt Lake City, Utah—Directors: G. A. Kositzky, Cleveland, Ohio; A. H. Lovell, Ann Arbor, Mich.; A. C. Stevens, Schenectady, N. Y.—National Treasurer, W. Slichter, New York, N. Y. (reelected).

L. G. CHASE, New York district manager of the Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa., while on a business trip through New York State, met with a serious automobile accident June 6, which resulted in his death June 10. Mrs. Chase, who accompanied Mr. Chase, sustained a fractured collar bone and several fractured ribs, but is now on the way to recovery. Born May 8, 1886, in Chadron, Neb., Mr. Chase came to New York early in life. He was graduated from Cornell University in 1908, and was a member of the American Society of Mechanical Engineers.

Characterized as "a champion of all good causes in this and other communities and a stalwart citizen of rare services," RUSSELL H. BALLARD, president of the Southern California Edison Co., Ltd., was awarded the honorary degree of doctor of business administration at the annual commencement exercises of the University of Southern California June 4 at the Los Angeles, Calif., coliseum.

E. R. DAVIS, manager of construction and engineering for the Southern California Edison Co., Ltd., for the past year, has been appointed assistant general manager. His appointment, effective June 6, was announced by Fred B. Lewis, vice-president and general manager. Mr. Davis has been associated with Southern California Edison and its predecessors since 1896. In 1911 he became general manager of Pacific Light & Power Corp., continuing in that capacity until 1917, when Pacific Light & Power was merged with Southern California Edison.

BUSINESS NOTES

The Abitibi Canyon development of Ontario Power Service Corp. reached an important stage June 13, when the dam received a water test for the first time since its construction began in April of last year. The site of the new dam, which will provide a head of about 237 ft., is on the lower Abitibi River, north of Cochrane, Ont., and the plant has been designed for five units of 66,000 hp. each, or a total of 330,000 hp. The development was undertaken in August, 1930, and an outlay of some $25,000,000 is involved.

Mason Regulator Co., Boston, Mass., announce the opening of a new office in Chicago at 1525 East 53rd St. The office will be in charge of William P. Gearon, who has represented the Mason Co. in Chicago for the past five years. This office will also be occupied by the Neilan Co., Ltd. (a Division of the Mason Regulator Co.) The Neilan representative is Arthur J. Foley.

The Ernest E. Lee Co., 115 So. Dearborn St., Chicago, has been appointed sales representative for the Elgin Softener Corp., Elgin, Ill. The Lee organization handles Chicago and northern Illinois.

The Ray Burner Co., San Francisco, Cal., has appointed The Case Hardening Service Co., 2281 Scranton Road, Cleveland, Ohio, as official representative for the sale of Ray oil burners in Cleveland and vicinity.

On and after July 1, the factory and main office of Holo-Krome Screw Corp., Hartford, Conn., will be located in Bristol, Conn.

How's Business?

The most and the worst that can be said of the situation is that business and security markets are marking time till something happens. This policy of wishful waiting for someone to say when and what, while timid statesmen and panicky politicians try to produce the rabbit of business recovery from the silk hats of incessant conferences and convention platforms, is conducive to fallen arches and weak knees in our economic system. Some of the smaller concerns are getting some exercise sawing wood and walking away with what business there is, but they do not stir up much movement in sodden statistics. Steel, coal, construction, textiles are sagging into extreme summer slackness, but automobile production is approaching its high point, and merchandise carloadings and electric power output (1,441,532,000 kw.-hr. for the week ending June 18, according to the N.E.L.A.) show some signs of improvement. Activity in some lines was temporarily stimulated by anticipation of the new excise taxes, but retail trade has contracted with consumer purchasing power. Security markets are dull but fairly steady. Commodities are a bit firmer. There are still no sure signs of credit expansion.—*The Business Week*, June 29.

STRAINERS—Fisher Governor Co., Marshalltown, Iowa—Bulletin 23 covers the line of "Fre-Flow" Fisher Type 260 of the self-cleaning type.

MOTORS—Wagner Electric Corp., 6396 Plymouth Ave., St. Louis, Mo.—A six-page loose-leaf bulletin on capacitor motors illustrates and describes the Wagner line or RZHR (rubber-mounted) and RZH (rigid-mounted) motors, including a history of the development of capacitor motors since the year 1892. The bulletin is 167, part 6.

BALL BEARING LUBRICATION—New Departure Mfg. Co., Bristol, Conn.—A leaflet on the subject of "Lubrication of Anti-Friction Ball Bearings" includes a chart explaining the four variables which must be dealt with in selecting a proper lubricant.

VACUUM HEATING PUMPS—Ames Pump Co., Inc., 30 Church St., New York, N. Y.—Bulletin 600 describes Type E low-return vacuum heating pumps. Includes breakdown drawings, diagrams and sizes and specifications.

CAPACITOR MOTOR—Ideal Electric & Mfg. Co., Mansfield, Ohio—Bulletin 210 gives full details of design characteristics and construction of Noel polyphase capacitor motor. This motor employs capacitors in a patented connection to obtain internally a power factor of unity or 80 per cent leading in squirrel-cage and slipring induction motors.

CONVECTION HEATERS—Commodore Heaters Corp., 11 W. 42d St., New York City—Bulletin No. 5 describes "Convection" heaters, built-in substitutes for radiators.

DUST COLLECTORS—Blaw-Knox Co., Pittsburgh, Pa.—Catalog No. 1391, "Positive Dust Collection at Low Cost," describes the company's framed bag dust collector and gives specifications and similar engineering information.

GRAPHIC RECORDING INSTRUMENTS—Esterline-Angus Co., P. O. Box 596, Indianapolis, Ind.—Catalog, "The Most Important Announcement Ever Made by The Esterline-Angus Company," describes new AW graphic recording meters.

SOLID FUELS & HAND-FIRING—The Committee of Ten Coal & Heating Industries, 1715 Dell Bldg., 307 North Michigan Ave., Chicago—Educational Bulletin No. 4, "Solid Fuels and Their Use in Hand-Fired Plants," a fairly comprehensive manual on the subject. Hand-fired large low-pressure heating plants are included in the explanation, as is a discussion of trouble shooting, classification of solid fuels and an explanation of terms and definitions. Copies may be secured from the committee at $0.25 a copy.

GAS BURNERS—Forney Combustion Engineering Co., 513 Central Bank Bldg., Dallas, Tex.—Descriptive folder, "Forney Gas & Oil Burners for Power Plant & Industrial Uses," introduces the Type BL burner made for gas pressures of 2 to 8 oz. with a head which can be supplied in a number of orifice sizes to give the particular rating desired with the gas pressure available.

New Plant Construction

Compiled by the McGraw-Hill Business News Department, Which Is Prepared to Furnish a More Complete Daily Service to Those Who Wish It

Ill., Hillsboro—Municipality plans the construction of an electric light and power plant. Warren & Van Pragg, Decatur, are engineers.

Ill., Lombard—City completed plans for construction pump house, including 1 sludge pump, 4 centrifugal pumps, electric motors, heating system. Estimated cost $250,000. Engr. Service Co., 53 South La Salle St., Chicago, is engineer.

Ind., St. Meinrad—St. Meinrad Academy plans construction of a water system and small power plant. Charles Brosman, Chamber of Commerce Bldg., Indianapolis, is engineer.

Ia., Ames—City, A. B. Maxwell, city clerk, awarded contract for construction of power and light plant addition and equipment, as follows, furnishing and erecting structural steel to Des Moines Steel Co., 421 Southwest 4th St., Des Moines, $8,643; constructing 16 x 60 ft. addition to turbine room, except steel to Ben Cole & Son, Ames, $7,902; furnishing one 3,000 kw. turbine generator to General Electric Co., River Rd., Schenectady, N. Y., $57,000; furnishing 1 condenser and auxiliary equipment to Foster-Wheeler Corp., 165 B'way., New York, $8,680.

Ky., Lexington—Lexington Utilities Co., plans the construction of a power plant at North Limestone St. Estimated cost $50,000.

La., New Orleans — Board of New Dillard Memorial University for Negroes, approved plans for group of buildings including power plant and laundry building, etc. Estimated cost is $2,000,000. M. H. Goldstein, American Bank Bldg., is architect.

Minn., Waconia — C. H. Ortlip, Recorder, awarded contract for construction of a municipal electric power and light plant to O. H. Olson, 3907 Upton Ave., Minneapolis; diesel engine to Fairbanks Morse & Co., Park Sq., St. Paul, and distribution system to Fisher Electric Co., Waconia.

Mo., Kirkwood—City Council will receive bids until July 8 for improvements to water works plant to increase capacity from 1,250,000 to 2,500,000 g.p.d. including 350 ft. 12 in. suction line, new clear well, reservoir 56x115 ft.; improvements to present settling basin, new filter units and rearranging present filters, one 750 g.p.m. pump and one 3,300 g.p.m. wash pump, etc. Joseph Wilson, City Hall, is engineer.

Mo., Osceola—City defeated bond issue to finance construction of a municipal light and power plant, distribution, etc. Estimated cost $30,000.

Neb., St. Edwards—City Clerk will take bids about June 30 on revised plans for construction of municipal light and power plant. Estimated cost $57,108. C. V. Barnhill, 420 Federal Trust Bldg., Lincoln, is engineer.

N. Y., Brooklyn — H. Hesterberg, Pres., Borough Hall, rejected bis for the construction sewage pumping station, at Flatlands Ave. and Paerdegat Basin.

N. Y., Diana—Bonaparte Light & Water Co., A. G. and G. W. Shoemaker, Diana, have applied for permission to construct an electric power plant and distribution system.

N. Y., Frankfort—Village Commission, plans the construction of a municipal electric plant, steam power. Estimated cost $110,000. F. T. Bolster, Rome, N. Y., consulting engineer.

N. Y., New York—Commissioner Department Mental Hygiene State Office Bldg., Albany, will receive bids until July 13, for heating work, repairing boilers, automatic combustion control system. Manhattan State Hospital, Wards Island.

N. Y., New York—Charles S. Makepeace, 30 Main St., Providence, R. I., plans installing a new heating plant in 5 story stores and apartment building at 130 First Ave. Estimated cost $40,000. Bowden & Russell, 19 West 44th St., are engineers.

O., Cincinnati—Cincinnati Union Terminal Co., Temple Bar Bldg., will receive bids until June 30, for the construction of a 2 story, 58x125 ft. power house at Railroad Yards. Estimated cost $150,000.

Okla., Durant—Ice Service Co., W. P. Hill, will build a 1 story, 20 ton per day capacity ice plant.

Ore., Stayton—Mountain States Power Co., has purchased the ditch and water rights of the Stayton Water Ditch and will build a new power plant. Estimated cost $45,000. J. K. Jorgeson, Medford, is engineer.

Pa., Philadelphia—Department of City Transit, C. C. Davis, Dir., City Hall Annex, awarded contract for furnishing, installing and relocating electrical equipment in substations in Broad St. subway, Contr. 220 to W. V. Pangborne & Co., Inc., 1927 West Montgomery Ave., $58,500.

S. D., Aberdeen—City plans election in August to vote on a proposal to issue $850,000 bonds for the construction of a municipal electric power plant and distribution system. Bemis Co., 332 South Michigan Ave., Chicago, Ill., are engineers.

Tenn., Memphis—Memphis Bonded Warehouse Co., Inc., Ellis B. Anderson, Pres., 20 Adams Ave., having preliminary plans prepared for the construction of a river and rail terminal including grain elevator, oil storage tanks, one 1 story and one 3 story building at Wolf River. Estimated cost $1,000,000.

Utah, Salt Lake City—Owner, c/o C. T. Van Winkle, Engr., Salt Lake City, plans construction of a hydro electric plant in Parleys Canyon by pumping water from Spiro Tunnel over divide (120 ft. lift) then dropping it down Parleys Canyon (1,500 ft. head). Estimated cost $400,000.

B. C., Greenwood — Wellington Beaverdale Syndicate plans construction of a power plant and will soon call for bids. Estimated cost $150,000.

B. C., North Vancouver—Capiland Timber Co., Ltd., plans construction of a power plant, shingle mill, lath mill and saw mill. Estimated cost $250,000.

Ont., Toronto—W. J. Stewart, mayor, City Hall, will receive bids until July 26, for supplying and installing equipment and appurtenances for purification plant at Victoria Park, incl. substation, controls, suction well, high lift pumping station, pumps, reservoir, filtration plant, laboratories, coagulating basin, etc. Estimated cost is $3,000,000. Gore, Nasmith & Storrie, 1130 Bay St., are consulting engineers. R. C. Harris, City Hall, is engineer.

Equipment Wanted

Generator Unit — Los Angeles, Calif. — T. Oughton, purchasing agent, will receive bids until Aug. 2 for 81,250 kva., 65,000 kw. power factor 0.80, voltage 13,800 phase 3-Y connector, 50 cycle, steam turbine, electric generator unit f.o.b. cars in accordance with Specifications No. 2827. Furnishing and erecting on purchaser's site at Wilmington, the first of two steam generating units and appurtenances, of 1,400 lb. per sq.in. maximum pressure, 1,350 lb. per sq.in. working pressure. Alternate bids will be taken on equipment of 480 lb. maximum pressure and 450 lb. working pressure. Specification No. 2826.

Gate Volves—Chicago, Ill.—Department of Public Works, A. A. Sprague, Comr., Room 406, City Hall, will receive bids until July 5, for design, fabrication and delivery of one 48 in. hand operated low pressure gate valve at the 14th Street Water Pumping Station, 1354 Indiana Ave. Also furnishing, delivering 18,000 ¾ in. and 8,000 1 in. bronze gate valves at Pipe Yard B, 3150 S. Sacramento Ave.

Lock Operating Machinery — Rock Island, Ill. — U. S. Engineer Office will receive bids until August 3, for lock operating machinery for two parallel locks, power house equipment, and electric power and control system for Lock and Dam No. 15, Mississippi River.

Pump—St. Cloud, Minn.—City plans to purchase one 500 g.p.m. pump with 50 hp. motor.

Power House Equipment—Bedford Hills, N. Y.—Commissioner Correction, State Office Bldg., Albany, will take bids until July 12, for replacing power house equipment at Westfield State Farm, Bedford Hills.

Boiler—Salem, Ore.—William Einzig, State Purchasing Agent, will take bids in July for a 250 hp. boiler for state penitentiary. Estimated cost $20,000.